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REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY, 1936

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., August 25, 1936.

Hon. HENRY A. WALLACE,
Secretary of Agriculture.

DEAR MR. SECRETARY: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1936.[1]

Sincerely yours,

IRA N. GABRIELSON, *Chief.*

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INTRODUCTION

SURVEY OF THE YEAR'S WORK

The major accomplishments of the Bureau of Biological Survey during the past year were based on the waterfowl-restoration program. This was launched last year and has been continued to the present under enlarged facilities provided by Congressional appropriations. Hand in hand with this program, however, has been a continuation of research, regulatory, and other functions concerned with wildlife conservation in general, with no relaxation in interest and attention and with a gratifying measure of accomplishment.

[1] This report covers parts of two administrations of the Bureau of Biological Survey. On Nov. 15, 1935, Jay N. Darling, who had directed the work during a critical period beginning Mar. 19, 1934, resigned to resume his professional work and to devote his energies to coordinating wildlife conservation activities throughout the Nation. The present Chief took office on Nov. 16, 1935.

The program of restoration of breeding, resting, and wintering grounds of wild fowl has been advanced, and the loss of birds from all causes, including hunting, has been curbed and offset. The restrictions placed on hunting last year were drastic. They were intended to reduce the kill by human agency, and in doing that they accomplished a constructive purpose. For the first time in years the Biological Survey's checks now indicate that more birds returned to the breeding grounds than in the preceding year, and checks by other agencies agree with the Bureau's reports. Realizing the impossibility of immediately restoring optimum conditions, the Bureau is directing its energies toward building up the breeding stock on unoccupied nesting grounds and providing additional areas suitable for the migrant birds during their sojourn in this country.

The Survey's program, while carrying no positive guarantee for the future of wild-fowling, at least provides a more hopeful outlook on the situation. This program is based mainly on two very simple premises: To perpetuate the species and, incidentally, to provide for the future of the sport of wild-fowling (1) we must have marshes where ducks can feed, rest, and breed, and areas where the birds can find suitable habitat in winter, and (2) we must annually return an adequate breeding stock of all species to the nesting grounds. If, while the refuge-restoration program is being carried on, the ducks should be exterminated, the marshes would be useless from the sportsman's standpoint and the expenditures by Federal and State Governments on the increasing scale of this program would have been in vain.

The basic problem of all wildlife conservation is closely associated with programs of land utilization. The restoration of wildlife, both game and nongame species, including the valuable fur animals, is entirely dependent upon a wise use of land. The program of wildlife conservation must thus be correlated with the general program of land utilization. The Biological Survey stands ready and most willing to cooperate not only with every agency responsible for administering Federal land but also with State and local agencies in other phases of land utilization, and to furnish each of them practical plans that will make provision for wildlife needs and interests without sacrificing other objectives in their administrative programs.

The Bureau has completed plans and inaugurated work in research and demonstration to enlighten an increasing number of private landowners not only on the necessity but also on the practicability of considering wildlife in their programs. To this end there have been put into operation this year nine cooperative wildlife research and demonstration stations in land-grant colleges situated in differing ecological regions of the country. Each unit is taking up a special line of research to furnish facts on which to base a correlated land-use program. As fast as the information is developed it will be applied to suitable definite land and water areas as a means of demonstrating the possibilities in wildlife management.

The conservation and restoration of wildlife is a tremendous task. The Nation in the past has riotously wasted this valuable natural resource, just as it has many other resources with which this continent was originally endowed. There is still opportunity to correct many former mistakes, but the only certainty of even measurable success depends on close cooperation of landowners and conservation agencies. The Biological Survey earnestly solicits continuance of cooperation of sportsmen, conservationists, and the general public to insure a constructive program of rebuilding the wildlife resources of the Nation. To save waterfowl from destruction by drought and drainage, from decimation by disease and depredations of natural enemies, and from overshooting by hunters, and at the same time to restore them to numbers approximating the abundance that gratified outdoor folk up to a few years ago, has been and continues to be the primary consideration in the Survey's activities as related to migratory birds. It is of great significance that, because of their relationships to the various phases of industry and recreation, these activities for the welfare of waterfowl, together with similar work for our resources in fur animals, big game, and other species of the wild, constitute a powerful stabilizing influence on the economic and social welfare of the Nation. At the same time, the healthful and tonic influences of an abundant wildlife are essential to any economy that is worthy of stabilization.

That there has been a reawakening to the need of wildlife conservation and restoration was amply demonstrated by the great public response to the President's call for the North American Wildlife Conference in February. Individual conservationists and representatives of National, State, Canadian, Mexican, and local organizations interested filled the Government's auditorium in

Washington and attended group meetings and viewed exhibits in space provided at a local hotel. The Chief of the Biological Survey presented a national wildlife program, and other members of the Bureau participated at the various sessions and in the preparation of exhibit material that presented facts in the Survey's several fields of conservation work. The Chief's program was later made available in mimeographed form and had wide distribution and reprinting in the daily press and in conservation periodicals. An important outgrowth of the wildlife conference was the temporary organization of the General Wildlife Federation and the selection of J. N. Darling as its temporary president. A limited edition of the proceedings of the conference was printed for the use of the Senate Special Committee on Conservation of Wildlife Resources, and the Congress, in a deficiency appropriation, made funds available to the Biological Survey for printing copies for more general distribution.

FUNDS AVAILABLE TO THE SURVEY

A total of approximately $10,248,000 from regular and emergency appropriations was available for the work of the Bureau of Biological Survey for the fiscal year 1936. Of this sum, $1,421,492 was carried in the Agricultural Appropriation Act for regular activities; an estimated total of $425,000 has been collected from sales of Federal migratory waterfowl hunting stamps; and a special appropriation of $6,000,000 for acquisition and development of wildlife refuges was approved June 15, 1935. Funds allotted to the Bureau from the Emergency Relief Appropriation Act of 1935 were as follows: For development of areas in North Dakota as Federal waterfowl refuges, $247,289; for acquisition of refuge lands, $428,384; for administrative expenses in connection with refuge land acquisition and development work on refuges, $203,090; and for expenses in connection with work performed by the Civilian Conservation Corps on Federal refuges, approximately $1,520,000. Toward the close of the year $2,690 was allocated to the Bureau from the Bankhead-Jones special research fund to begin an economic study of wildlife management as a supplementary farm enterprise.

THE BUREAU'S ORGANIZATION

Changes in organization during the year affected only sections of divisions, the work of the Bureau being conducted under six divisions as in the preceding year. In the Division of Wildlife Research the Section of Mammalogy was given enlarged functions by allocation of duties formerly handled directly by the chief of the Division and its designation changed to Section of Wildlife Surveys, effective May 27, 1936. In the Division of Public Relations a reorganization of two sections became effective on March 21, following the retirement of Lisle Morrison, formerly in charge of the Section of Visual Information and Publication Distribution. Press and radio work was separated from the former Editorial and Information Section, and two new sections were established: (1) The Editorial Section and (2) the Section of Current and Visual Information.

The present organization, with officials in charge, is as follows:

Chief of Bureau—Ira N. Gabrielson
Associate Chief—W. C. Henderson
Technical adviser and research specialist—W. L. McAtee
Division of Administration—W. R. Dillon
Assistant—Thos. E. Jacoby
Section of Personnel and Pay Rolls—E. J. Thompson
Section of Accounting—S. C. Moore
Section of Purchases and Property—J. L. Talbert
Section of Mails and Files—W. D. Hobbs
Division of Public Relations—H. P. Sheldon
Assistant, in charge of Editorial Section—Wm. H. Cheesman
Section of Current and Visual Information—Howard Zahniser
Division of Wildlife Research—W. B. Bell
Section of Wildlife Surveys—H. H. T. Jackson
Section of Distribution and Migration of Birds—F. C. Lincoln
Section of Food Habits—Clarence Cottam
Section of Fur Resources—Frank G. Ashbrook
Section of Disease Control—J. E. Shillinger
Division of Land Acquisition—Rudolph Dieffenbach
Section of Appraisals and Negotiations—R. M. Rutherford
Section of Surveys and Maps—A. A. Riemer
Division of Migratory Waterfowl—J. C. Salyer II
Assistant, in charge of Section of Maintenance and Patrol—A. C. Elmer
Section of Reconnaissance and Habitat Improvement—W. F. Kubichek
Section of Restoration and Development—Amos B. Emery
Division of Game Management—Stanley P. Young
Assistant, in charge of Section of Big Game Refuges and Game Agents—W. E. Crouch
Section of Law Enforcement—F. P. Callaghan
Section of Importations and Permits—R. W. Williams
Section of Predator and Rodent Control—A. M. Day

VETERAN RETIRED

The retirement of Lisle Morrison on February 29, at the age of 70, came after 40 years of nearly continuous service with the Federal Government, 18 years with the War Department and 19 with the Department of Agriculture (3 years were spent in private business). His last 17 years were with the Biological Survey, following services in the Bureau of Plant Industry in charge of congressional seed distribution and dry-land seed distribution, and in the Office of Farm Management as assistant to the Chief. In the Survey he became assistant to the chief of the division that had charge of predator and rodent control and later was in charge of the Bureau's exhibits, photographic work, and distribution of publications.

OUTSTANDING EVENTS OF THE YEAR

The events that marked the past year's work of the Biological Survey may be briefly noted as follows, the details being given on subsequent pages:

RESEARCH WORK

Research center.—Establishment of a research center at the Wichita Mountains (Okla.) Wildlife Refuge; and beginning of construction of a wildlife laboratory.

Cooperation at stations.—Inauguration of cooperative wildlife research and demonstration stations at nine land-grant colleges centrally situated in ecological regions.

Waterfowl habitat.—Utilization of the major flyways concept in organizing field investigations of waterfowl abundance; and a midwinter inventory of waterfowl resources from land, water, and air, through cooperation of Federal and State officials.

Birdbanding.—Banding more than 225,000 birds of various kinds and receipt of more than 18,000 reports of subsequent recoveries of banded birds; and arrangements to extend waterfowl banding work into Mexico.

Eelgrass transplanting.—Planting of Pacific-coast eelgrass at certain points on the Atlantic coast in an experiment to reestablish an important waterfowl food all but eradicated by disease; and initiation of studies of harvesting, storing, and germination of other waterfowl food plants.

Drainage investigations.—Successful curbing of several drainage projects that threatened injurious effects on waterfowl food resources; and renewed efforts to insure preservation of wildlife habitat in mosquito-control work.

Crow depredations.—Initiation of a study of the effects of crow-waterfowl relationships on breeding grounds and of efforts to determine the effects of rigorous crow control on duckling mortality.

Fox-quail relationships.—Investigation of fox depredations on quail through a study of the mortality at nests; and determination of the local food habits of foxes.

Fur-station purchase.—Congressional authorization to purchase the land in New York on which is located the Fur Animal Experiment Station.

Rabbit studies.—Development of a self-feeding system at the Rabbit Experiment Station, in California, that reduces feed costs with production of superior-quality meat; and aid to rabbit breeders through studies of bloat to determine whether the malady is influenced by different kinds of feed.

RESTORATION OF WATERFOWL HABITAT

Special funds.—Availability of Congressional appropriation of $6,000,000 for continuing the migratory waterfowl restoration program, involving acquisition during the year of 13 new refuges and enlargement of 9 others.

Drainage projects.—Cooperative arrangements with the Works Progress Administration whereby the Biological Survey will investigate all proposed drainage projects that may materially affect wildlife environment.

Easement refuges.—Creation of lakes and marshes and other development work on 32 refuge areas in North Dakota dedicated to wildlife conservation by easements.

WILDLIFE CONSERVATION AND REFUGE ESTABLISHMENT

Wildlife Conference.—The President's call for the North American Wildlife Conference and the temporary organization resulting therefrom of the General Wildlife Federation.

Refuge development.—Successful completion of numerous projects for the development and improvement of waterfowl and other bird and big-game refuges primarily with services furnished by 28 camps of the Civilian Conservation Corps.

Land acquisition.—Consummation of negotiations for the acquisition of 811,785 acres of refuge land, at an average cost of $4.26 an acre, vesting of title in the United States to 227,900 acres, and completion of valuation appraisals on 1,521,380 acres.

Antelope range.—Issuance of Executive orders establishing the Hart Mountain Game Range for antelope (469,877 acres in Oregon and 528,794 in Nevada); and adding approximately 3,800 acres of public lands to the Charles Sheldon Antelope Refuge in Nevada chiefly to protect mule deer.

Mountain sheep range.—Establishment by Executive order of the Desert Game Range of 2,022,000 acres in Nevada primarily for the conservation of Nelson's mountain sheep.

LEGISLATION AND REGULATION

Mexican treaty.—Negotiation of a treaty with Mexico for the protection of migratory birds and game animals following dispatch of two scientists to that country to aid in preliminary work; and passage by Congress of enabling act, to be effective upon exchange of ratifications.

Hunting regulations.—Indication of beneficial effect of more stringent hunting regulations in increased returns of waterfowl to the nesting grounds.

Law enforcement.—First year's enforcement under the amended Lacey Act; adoption of the three-shell gun regulation in hunting waterfowl; outlawing the use of live decoys in hunting ducks and geese; and prescribing a straight 30-day season on waterfowl.

PREDATOR AND RODENT CONTROL

Predators.—Continued increase in abundance of coyotes and other predators in spite of larger numbers taken through control operations than ever before; and extension of cooperative control to North Dakota and Missouri.

Rodents.—Reduction of rodents on 32,547,769 acres directed by Bureau specialists to protect farm crops, range grasses, silvicultural plantings, and reclamation waterways, and to prevent waste of surface soils from erosion.

Rats in Hawaii.—Extension of rodent control to Hawaii, where rats seriously interfere with pineapple and sugarcane production and menace public health as carriers of bubonic plague.

RESEARCH ON WILDLIFE STATUS AND DISTRIBUTION

WATERFOWL STATUS

Continuing investigations previously inaugurated on the waterfowl breeding grounds in Canada, four parties were again in the field this year in British Columbia, Alberta, Saskatchewan, Manitoba, Nova Scotia, and New Brunswick. Work in the two Maritime Provinces was an extension of previous activities and was undertaken because of the particularly unsatisfactory condition of the black ducks and Canada geese using the northeastern flight of the Atlantic flyway. Conditions on all breeding grounds were found to be improved, with good prospects for the best hatch in several years. It was noted, however, that waterfowl in general, particularly some of the most desirable species, as the redhead and the canvasback, were in such a precarious situation as to necessitate heroic measures to reduce the legal kill. The improved conditions can be attributed directly to the drastic regulatory action taken last season, the number of birds surviving the shooting season being greater than in the previous year. This fact was demonstrated in the investigations that were continued during the fall migration and had as their culmination the midwinter inventory.

Organized on the basis of the eight game-management regions, the midwinter inventory was a most gratifying demonstration of cooperative effort. The field studies, simultaneously made, were conducted by the regular field personnel of the Bureau (biologists, game-management agents, district agents, refuge managers and superintendents, wildlife technicians, and others), augmented by State game wardens and personnel from the Forest Service, the Soil Conservation Service, the Bureau of Public Roads, and State police, and by observers from certain State colleges, volunteer cooperating observers of the Survey, and members of the National Association of Audubon Societies. Most of the travel was by automobile and motorboat, some by airplane. In addition to the regular patrol boats of the Biological Survey, boats were furnished by State game commissions, the Bureau of Navigation and Steamboat Inspection, and the Coast Guard. The entire coast line also was covered by air in seaplanes or blimps furnished by the Navy Department, the Coast Guard, the War Department, and a commercial tire and rubber company. Land planes also were assigned to the work by the War Department and the National Guard of Connecticut. Aerial surveys are particularly useful for such work.

Field studies were continued in Mexico by an expert biologist with an assistant, but because of duties connected with the proposed treaty for the protection of birds and mammals, the coverage of that country was not so extensive as in the previous year. No important change, however, was observed in the relative numbers of ducks and geese wintering in Mexico. These two investigators also made a study of the desert mountain sheep of southern Baja California, the travel expenses being provided by a cooperator of the Bureau, who accompanied the expedition. The region explored is at the southern end of the range of the bighorn, and valuable information as to the status of the species there was procured.

Reports on fall and spring migrations were made by 647 selected observers.

At the close of the fiscal year five parties were again on breeding grounds in Canada and Newfoundland. In addition to resuming studies in regions surveyed during the past 2 years the party visiting the Maritime Provinces extended its operations to the Gaspé Peninsula, Quebec, and to Newfoundland, while in the interior, a trained biologist was pushing his way northward through Lake Athabaska, Great Slave Lake, and on down the Mackenzie River to its mouth, where he planned to remain until the freeze-up, before returning by air through Yukon Territory and Alaska.

BANDING GAME AND OTHER BIRDS

Birdbanding operations during the year were materially expanded to include regular activities at some of the newly created waterfowl refuges. Such work should be effective in solving some of the more difficult administrative problems concerning the birds of the different flyways. Banding is now being done by 2,077 station operators, who during the year placed bands on 274,695 birds, an increase of nearly 25,000 over the preceding year. Recaptured banded birds to the number of 18,268 were reported.

Migratory waterfowl continued to receive first attention, and the results are shown in table 1. Effort also has been made to have certain stations concentrate on some of the more difficult groups, including herons, birds of prey, and shore birds, with the result that the number of herons banded increased from about 2,000 in 1935 to 3,356 in 1936; of vultures, hawks, and owls, from about 1,800 to 2,358; and of shore birds from about 2,000 to 5,852. A digest of work accomplished for the fiscal year 1935 was sent to cooperators in an issue of multigraphed Bird Banding Notes (no. 13, of vol. 2). A mimeographed leaflet (BS–53) entitled "Birdbanding" explains the history and purposes of this means of investigation. Arrangement has been made with the editor of the quarterly journal, Bird Banding, to include in each number a paper dealing with the more outstanding recovery records for different groups of birds. This will make available in published form many valuable data on migration, homing instinct, longevity, and other phases of life history that would otherwise remain buried in the office files. Two such papers have already appeared.

TABLE 1.—*Waterfowl banded in the fiscal years 1935 and 1936*

Species	1935	1936	Species	1935	1936
	Number	*Number*		*Number*	*Number*
American merganser	----------	12	Greater scaup	156	227
Red-breasted merganser	8	2	Lesser scaup	1,299	906
Hooded merganser	5	10	Ring-necked duck	1,073	1,357
Mallard	14,947	14,526	American goldeneye	3	2
Black duck	4,037	4,283	Bufflehead	84	55
Gadwall	85	173	Harlequin	----------	6
Baldpate	689	657	American eider	22	1
Green-winged teal	2,307	2,642	White-winged scooter	2	1
Blue-winged teal	973	2,475	Ruddy duck	15	16
Cinnamon teal	42	215	Snow goose	73	----------
Shoveler	75	100	Blue goose	53	68
Pintail	15,177	11,894	White-fronted goose	1	4
Wood duck	435	597	Canada goose	302	436
Redhead	350	521	Whistling swan	1	3
Canvasback	213	553			
			Total	42,427	41,742

RECORDS OF BIRD DISTRIBUTION

Distribution and migration data noted on about 42,000 cards were added to the files during the year, representing original observations and material abstracted from contemporaneous literature. The names of 378 volunteer migration observers are carried on the list.

Distribution maps of the important group of shore birds have been completely revised during the year, and material has been assembled for similar work on the economically important gulls and terns. A special series of maps has been prepared showing the relationship between existing refuges and the original and present breeding ranges (United States only) of migratory and upland game birds and the larger game and fur mammals.

Circular 363, entitled "The Migration of North American Birds", was issued, and, despite a fairly large edition, both the free and the sales stocks were promptly exhausted. This publication brings to date, in a popular yet scientific manner, the information that has accumulated during the last 20 years on the fascinating subject of migration. It supersedes Department Bulletin 185, which has been one of the most popular publications issued by the Survey. Bird Migration Memorandum No. 1, containing a series of tables and an analysis of the spring migration of 1935, was mailed to all cooperating observers and others interested, and the response has been most satisfactory.

Data obtained from State game commissions regarding the various species of upland game birds occurring in their respective States have been placed on county-line maps as a first step in this study. Further analysis will be undertaken with the collaboration of certain specialists to show the Nation-wide situation concerning this important group.

INVESTIGATIONS IN ALASKA

BUFFALO HERD

In order to obtain information as to the status and condition of the buffalo introduced some years ago on the buffalo range near McCarty, Alaska, a Bureau employee made an investigation at his own expense and traveled on foot over much of the range between the Big Delta River and Jarvis and Granite Creeks. He was unable to cover the west side of the Big Delta where the animals are chiefly concentrated. Interviews with several persons at McCarty warrant the opinion that the herd now numbers at least 150 buffalo.

MUSK-OX HERD

The musk-ox herd introduced in Alaska in 1930 has continued to do well. No calves were born this spring, a fact that is of scientific interest and may possibly be explained by the fact that the calves, not having been separated from the cows last fall as during the previous year, were not weaned and thus the cows did not breed. It has been stated, however, though not verified, that the wild musk ox in its native habitat produces young only once in 2 years.

It would appear possible, therefore, that, by controlled weaning, the number of offspring over a period of years may be increased. At the close of the year 27 animals remained in the herd at Fairbanks. It has been decided to transfer these to Nunivak Island, where four others, transferred earlier in the year, survived the winter in good condition. Under warden protection in their new surroundings these animals should thrive and increase.

WILDLIFE RECONNAISSANCE OF ISLANDS

A 5-month reconnaissance of wildlife conditions on the major islands of the Aleutian chain was begun in April. The field party, including two biologists, embarked on the Bureau's patrol boat *Brown Bear*. At the close of the year several islands of the Aleutians as far west as Seguam had been studied, and interesting and valuable new information obtained, which in some cases has greatly changed ideas as to the wildlife conditions. This expedition has also discovered important bird colonies not heretofore mentioned in reports or literature.

STUDIES OF FOREST AND RANGE FAUNA

Biologists have continued research during the year on the relationships of wildlife to forestry, grazing, and other land uses in cooperation with certain forest experiment stations. Particular attention has been paid to the relationship of rodents and birds to forest reproduction, with special reference to damage to seeds and seedlings of forest trees.

In Minnesota these studies concentrated particularly on the snowshoe hare, as a result of which three manuscripts have been prepared for publication. Studies also were made of methods of planting for wildlife and of the results, both in forests and in aquatic situations.

In the Pacific Coast States research was conducted on the relation to forest regeneration of mice and of rabbits of a different species from those in Minnesota as well as on wildlife in relation to the range. In the range studies separate enclosures were made for various species, including the California ground squirrel, kangaroo rats, and pocket gophers. Enclosures also have been laid out for the study of the effect of burrowing rodents on soil.

Research was continued on the Pillsbury State Forest in New Hampshire until May 15, when it was necessary temporarily to suspend work on the project. The phases of wildlife management studied included cover manipulation and the response of wildlife species, the development of satisfactory food plants after experimental work in determining requirements of the plants and of the species of wildlife for which intended, cultural methods to be used in the management of covers, and the movements and seasonal requirements of game species. Special emphasis in the New England studies was placed on the ruffed grouse.

At the Harrison Experimental Forest in Mississippi investigations of the destruction of pine seed disclosed that, although other birds were involved, migrant flocks of blackbirds were largely responsible. Research on the natural history of the mourning dove was conducted at this station, and distributional studies were made of birds and mammals of the Gulf coast region.

Surveys of national forests in Virginia, Florida, Missouri, Mississippi, and Louisiana have been made under a cooperative agreement with the Forest Service, each involving the biological evaluation of a forest as a wildlife area at present and a series of recommendations for its improvement. Among the things recommended were that grazing of cattle and running of hogs be stopped or restricted, that the number of hunting dogs in a pack be limited, that refuge areas be fenced, that more paths be opened, that through traffic roads be blocked off, and that controlled burning be employed to clear out underbrush. It was also recommended that for restocking purposes wild deer, turkeys, and quail be imported from similar areas, avoiding the introduction of stock from areas of similar climate but of different terrain; game moved hundreds of miles from one area to another in the Coastal Plain, for example, may have a better chance of survival than stock moved 200 miles from Coastal Plain to Piedmont terrain that are subject to the same climate conditions.

Another phase of the cooperative work with the Forest Service has been a study, just completed, of reports on bio-ecological conditions in the national forests of the Northwest and the presentation of comprehensive recommendations for their improvement as wildlife areas.

To determine the feasibility of restoring the wild turkey as a game bird in Missouri, an investigation was begun early in 1936 through cooperation with the Forest Service and the Missouri Game and Fish Department. Studies of native wild turkey populations are being made as to distribution, food habits, water use and requirements, and ranging habits late in winter and early in spring and throughout the breeding season. Observations also are being made on 10 separate demonstration areas of several different systems of restocking. Work thus far has been confined to the approximately 450,000 acres of the Fristoe division of the Clark National Forest purchase unit. General reconnaissance has been extended to areas of turkey concentration throughout the 3½ million acres of the Gardner and Clark National Forests, all of which lie within the Missouri Ozarks turkey range. Headquarters, transporation, and field assistance are being furnished by the Forest Service, and demonstration areas and birds for restocking studies are being supplied by the State game department. Some 1,200 artificially propagated wild turkeys have been furnished for this purpose over the past 2 years. Establishment and maintenance of field demonstrations have been facilitated by the camps of the Civilian Conservation Corps and forces of the Emergency Relief Administration.

It is planned to make the Wichita Mountains Wildlife Refuge, Okla., one of the principal field research areas for the study of wildlife, particularly in regard to game-management procedure. Progress has been somewhat delayed pending the completion of the laboratory at refuge headquarters, but preliminary plans have made good headway. Five scientists have been detailed to the refuge for brief periods during the year, a cursory survey of animal life has been made, and specific data have been gathered for formulating a research program. Enclosures for a study of the vegetation have been fenced as well as areas for grazing research.

BIOLOGICAL SURVEYS OF REFUGE AREAS

In cooperation with representatives of the National Park Service, the University of Arizona, and the Mexican Department of Forest, Fish, and Game, three members of the Bureau biologically explored vast areas of the desert regions of Yuma and Maricopa Counties, Ariz., and made recommendations as to the desirability of establishing a large wildlife refuge and a national monument in that section. The same party also investigated a large area south of the Gila River in Pima and Yuma Counties, with a view to noting its adaptability as a national wildlife refuge. The same group, with the University of Arizona representative replaced by one from the New Mexico State Fish and Game Commission, examined the Big Hatchet-Playas area in Hidalgo County, N. Mex., and recommended that it be included within an international wildlife refuge project.

Many prospective refuge areas have been examined with a view to learning the wildlife inhabitants and their distribution on the projects, as well as the nature of conditions confronting the various species. Two biologists investigated an area in the vicinity of Fort Peck, Mont., to determine its suitability as a wildlife refuge and found that although there would be a large body of water in the reservoir to be created, it would be of little value as a nesting ground for waterfowl because of fluctuating levels and lack of permanent shore-line vegetation. It should, however, prove a good resting refuge for waterfowl. An area near the Billage Creek section was found suitable for mountain sheep, the Dry Creek drainage for pronghorn antelope, and the western end of the area for elk and bison. Other prospective refuge sites were examined in Florida and Georgia.

During August 1935 a biologist who investigated a proposed elk range on the Salmon National Forest, Idaho, found that elk could well be introduced on the Salmon River section, in the wilderness area, but that on the eastern part conditions were not so favorable, the area there being already populated with deer and antelope as well as domestic sheep.

Planning surveys also were made by three Bureau scientists in August on the Big Levels Game Refuge in the George Washington National Forest, Va., as a result of which many concrete recommendations were advanced for its improvement for game and other wildlife. Several of these recommendations, already put into practice, have resulted in a noticeable improvement in wildlife conditions on the area.

Two biologists spent nearly a month early in the spring checking wildlife conditions on the Ocala National Game Refuge and the Ocala National Forest, Fla. Certain parts of this area support deer, raccoons, and other game and fur

species, whereas others are scantily inhabited. Biological problems here involve the production of a more general distribution of species locally plentiful on the refuge and the increase of stock of certain species now scarce. Introduction of outside game stock does not seem necessary.

Game drives for taking area censuses of game, particularly deer, were observed on the Alleghany National Forest, Pa., in December, and other cooperative game-management studies were conducted on this forest at other periods during the year.

At the request of the Tennessee Valley Authority a study was made of wildlife and its environmental conditions in the area, covering approximately 130,000 acres and bordering the land covered by Norris Lake, northeast of the Norris Dam. Definite recommendations were formulated regarding wildlife practices suitable to areas selected for refuges, aggregating about 25,000 acres.

Upon request of a State representative of the Works Progress Administration, study was made of game lands in Centre County, Pa., and recommendations were submitted for improvement of the environment for wildlife, to be put into effect by a work camp of the W. P. A.

Inspection of wildlife management work on Soil Conservation Service projects in North Carolina and a report suggesting additional measures were made on invitation of the regional biologist of that Service.

The Chief of the Division of Wildlife Research represented the Bureau on the International Commission of the United States and Mexico to make field studies of the possibilities for establishing international parks and wildlife refuges at places along the boundary of these two countries. The commission in February investigated the Big Bend region of Texas and Mexico, including the Chisos Mountains, Tex., the Rio Grande Valley, and the Del Carmen and Frontereza Mountains, Mexico, as well as adjacent areas. Exploration of other regions was planned, but the expedition was terminated suddenly when a lamentable automobile tragedy resulted in the death of two members of the commission—George M. Wright and Roger W. Toll, of the National Park Service.

COOPERATIVE RESEARCH IN WILDLIFE MANAGEMENT

The plans for establishing a series of research units in cooperation with land-grant colleges and State game departments, mentioned in last year's report as under way, materialized during this year. Arrangements have been made for the establishment of nine such units, for each of which funds are to be provided annually as follows: Project leader's salary, by the Bureau of Biological Survey; $3,000 in cash, by the American Wildlife Institute; not less than $6,000 in cash or its equivalent in services, equipment, or facilities, by the land-grant college; and not less than $6,000 in cash or its equivalent in services, equipment, or facilities by the State game department. Units now established and at work are as follows:

Alabama Polytechnic Institute, Auburn, Ala.
Connecticut State College, Storrs, Coun.
Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.
University of Maine, Orono, Maine.
Ohio State University, Columbus, Ohio.
Oregon State Agricultural College, Corvallis, Oreg.
Agricultural and Mechanical College of Texas, College Station, Tex.
Utah State Agricultural College, Logan, Utah.
Virginia Polytechnic Institute, Blacksburg, Va.

All the State programs are now under way; the 9 project leaders have been assigned; 19 graduate assistants are at work on special problems as well as 7 full-time research assistants, 8 part-time research and field assistants, and approximately 16 temporary summer student assistants, with a large part of the work by contributed time of college staff members; college participation, with one or two exceptions where final arrangements will soon be completed, has been worked out; game departments have met their obligations in full; the general State programs and programs of work for the next year are completed; valuable data have been obtained; and some informational literature has been published and considerable educational work done. A conservationist assigned to assist in supervising this project spent most of the year in field organization.

For each unit there is a balanced program between (1) research and investigation in wildlife history and management; (2) establishment of trial or experimental demonstration areas comprising object lessons of wildlife-management practice; and (3) educational activities, embracing the training of men in wildlife management work and the preparation of information for the public.

Major life-history and management studies are under way for mourning doves, New England cottontail rabbits, waterfowl in the Prairie States, Mearns' cottontail rabbit, muskrats, woodcock, gray squirrels, raccoons, Oregon antelope, Attwater's prairie chicken, Rocky Mountain mule deer, Columbian sharp-tailed grouse, and wild turkey. Other species and problems are being studied in more or less specialized aspects, and each State has under development one or more demonstration management areas.

Outstanding among the encouraging features of the program are: (1) The genuinely wholesome attitude of game departments toward the work; (2) recognition of the general importance and sincere interest manifested by all agencies concerned with wildlife; and (3) realization by the colleges and land-use agencies of the potentialities in the wildlife field and the necessity of studying wildlife from the land-use standpoint.

Mimeographed leaflet (BS–38) describing the progress made in cooperative research in wildlife management was issued in February, and a press release covering the work was distributed in April.

At the annual meeting in Washington, D. C., in November, of the Association of Land Grant Colleges and Universities, the Chief of the Bureau spoke on Relations of Agriculture and Game Management. The address has since been distributed in mimeographed form. He also was author of an article entitled "The Correlation of Forestry and Wildlife Management" published in the Journal of Forestry.

REFERENCE COLLECTIONS AND RECORDS

Continued progress was made in assembling and recording data based on collections of specimens and on reports regarding habits, life histories, relationships, and distribution of mammals as well as birds. During the fiscal year 269 mammal specimens were added to the Biological Survey collection and 1,758 were identified for 40 institutions and individuals in 21 States and 1 foreign country. Specimens to the number of 1,072 were borrowed for study from 9 institutions in 6 States and 1 foreign country, whereas 404 have been loaned to 4 institutions in 3 States. The facilities of the mammal laboratories were used by 36 research workers, other than Bureau employees, from 16 States and 1 foreign country. Scientists of the Bureau using this collection described as new 28 mammals belonging to the genera *Canis*, *Martes*, *Gulo*, *Lutra*, *Thomomys*, and *Cervus*. Mammal type specimens now in the Biological Survey collection number 932.

Bird specimens added to the Biological Survey collection during the year numbered 305, and 2,076 bird specimens were identified for 65 institutions and individuals from 30 States. Loans from the collection to 11 institutions and individuals in 7 States aggregated 466 specimens.

Of special importance among studies of selected groups is the beginning of an intensive research on the relationships and distribution of the tree squirrels. In order to facilitate investigations upon this large assemblage of many species, smaller groups of related species will be studied separately, and work has already advanced on the red squirrels (genus *Tamiasciurus*) with descriptions of four heretofore unrecognized forms prepared for publication and much new information gained as to their distribution.

A study of the taxonomic relations, distribution, and history of the pumas has been continued, and a distributional study of the Arctic hares has been completed for outside publication. Naming the Animals, a brief story of the Bureau's taxonomic study of mammals, was presented as a radio talk February 28. A manuscript entitled "Planning for Wildlife in the United States" was published as part IX of the Supplementary Report of the Land Planning Committee to the National Resources Board, 1936. Of the noteworthy papers based on Bureau studies, issued in outside publications, one dealt with relationships of the economically important rodents of the *Thomomys bottae* group of pocket gophers, the other with the classification and distribution of the main land otters.

A mimeographed leaflet (BS–12) entitled "The Present Plight of the Jackson Hole Elk" was issued as were also a press release and a radio talk on the elk problem.

An account of the habits, natural history, and relationships of the caribou was published in August under the title "Alaska-Yukon Caribou", as North American Fauna No. 54, and a talk on Conserving the Caribou, Our American Reindeer, was broadcast by radio in March.

Wildlife Review, a mimeographed leaflet of irregular frequency of publication, was inaugurated during the year. Its primary purpose is to abstract the literature of the broad field of wildlife management and to inform readers as to where and how the publications abstracted can be obtained, but some special articles, bibliographies, and notes and news on the subject also are included. During the year four issues appeared, totaling 134 pages and containing abstracts of 291 books, bulletins, leaflets, and articles.

ECONOMIC INVESTIGATIONS OF WILDLIFE

WATERFOWL-FOOD STUDIES

EELGRASS AND BRANT

The status of eelgrass along the Atlantic seaboard has been one of continuing importance and interest. Reports both of great improvement and of total disappearance have been received, but a balancing of observations made throughout the range of this plant now indicates a slight improvement. In many places where the eelgrass has failed to come back wigeongrass has taken over the area and made a good growth. This plant, however, is also an excellent duck food and affords some harbor for small animal life.

The dependence of brant on eelgrass for the major part of their food continues to be manifest in an abundance of brant on the Pacific coast and a relative scarcity along the Atlantic. Early reports of increased numbers in the 1935 hunting season are to be attributed to the accumulation of most of the eastern birds in New Jersey, few having migrated to the more southern wintering grounds.

EXPERIMENTAL TRANSPLANTINGS OF FOOD PLANTS

Seeds and rootstocks of the Pacific coast form of eelgrass (*Zostera marina* var. *latifolia*) have twice been shipped east by different methods for planting in Atlantic coastal waters, in the hope that they might be propagated to replace the indigenous form. The Pacific coast form has been experimentally set out at various points from New York to North Carolina. Likewise, transplants have been made of healthy-appearing Maryland stock of the eastern form to coastal waters of Virginia and New York. Though too early to report conclusive results, some of the material from the west coast set out on Long Island, N. Y., has held up better than stock from Chesapeake Bay. Further experimental work is contemplated.

Several transplantings of wigeongrass (*Ruppia maritima*) to apparently suitable areas where it has not occurred naturally have been effected.

Experimental transplantings of halodule (*Halodula wrightii*), a plant intermediate in appearance between eelgrass and wigeongrass, and of the closely related Florida manatee grass (*Cymodocea manatorum*) have been made at the Cape Romain Migratory Bird Refuge in South Carolina. The former species has been found in duck stomachs, and since it may prove to be a valuable duck food, further transplantings are planned.

Experimental plantings have been made at several places in the State of Washington to test the adaptability for more widespread distribution of plants that have been highly recommended as waterfowl foods, particularly delta duck potato (*Sagittaria platyphylla*), wildcelery (*Vallisneria spiralis*), and banana waterlily (*Nymphaea mexicana*).

PROPAGATION STUDIES

In addition to making experimental transplants of vegetative parts of several important species of waterfowl foods, seeds or tubers of many species were harvested last summer and fall and stored over winter for experimental sowing in suitable areas on bird refuges. The leafy cuttings (terminal branches) of many submerged food plants were found to take root readily and to afford an easy method of propagation, with more rapid results than seeding. Germination tests already undertaken with the seeds of various marsh and aquatic plants demonstrate that low-temperature storage is essential for uniform germination. Seeds of aquatic and marsh plants collected in the Northern States should, in general, be subjected to a 3- to 6-month period of afterripening in water, or stratified between moist layers of sand (or finely ground peat moss in

the case of the heavy-coated seeds of some marsh plants), at a temperature of 1° to 5° C. It was found that, in less than 6 months, dry storage of the seeds of most marsh and aquatic plants destroyed the embryos of species having thin seed coats and greatly retarded growth of those having heavy seed coats. In the vicinity of Washington, D. C., freezing in ice for 2 weeks at —5° to —10° was found to have destroyed the embryos of the seeds of the long-leaved pondweed (*Potamogeton americanus*), but seeds of the salt-marsh bulrush (*Scirpus robustus*) treated similarly germinated satisfactorily. Many of the findings have been corroborated by the New York State College of Agriculture, and additional information has been derived from cooperative research with this institution.

NEW WATERFOWL FOOD

The flowering rush (*Butomus umbellatus*), a European adventive well established at the south end of Lake Champlain, was investigated with reference to its value as a waterfowl food. Though it produces large quantities of seeds, these are apparently too minute to be of outstanding food value. The sweet and palatable tubers, however, often exposed close to the surface, were found to have been eaten by green-winged teal and may prove to be a valuable new source of waterfowl food.

ECOLOGY OF WATERFOWL FOOD PLANTS

In continuing chemical and physical studies in southeastern waters to gain knowledge of the ecological requirements of some of the outstanding waterfowl foods, special emphasis has been placed on a study of the effects of variations and fluctuations of salinity on the growth of food plants and on the retarding action of highly stained or turbid waters on the nature and abundance of submerged vegetation. During periods of prolonged drought increased salinity has been found highly destructive to fresh-water vegetation, causing changes in the relative abundance of various aquatic plants and usually resulting in an increase in the growth of salt-water species. A rapid recovery of fresh-water vegetation after the return of normal conditions has been noted.

PEST PLANTS

Water caltrop (*Trapa natans*), an introduced plant that is impeding navigation and competing with good duck foods in the Potomac River, has continued to increase. Following the exceptional spring floods on the Potomac River the plant spread over an increased area and the nutlike fruits have been recorded from several new localities, as far south as Point Lookout. These fruits, designated caltrops because of the protruding horns that may injure bathers, have been found by the hundreds in the drift at swimming resorts. Results of experiments in the control of this plant in the Erie Canal, New York, by use of C. C. C. labor and mechanical methods, have been followed with interest. Information collected on the development and methods of control of water caltrop is being summarized for publication as a leaflet.

FOOD SURVEYS OF REFUGE AREAS

Areas in Maine, New York, Delaware, Virginia, North Carolina, South Carolina, Georgia, Florida, Minnesota, Illinois, Kentucky, Missouri, Louisiana, Oklahoma, Texas, and New Mexico were surveyed for food resources and consequent biological adaptability for use as waterfowl refuges. Where acquisition was recommended further suggestions were made for the improvement of the area for refuge purposes. Similar, though more specific, surveys and recommendations were made of a few Federal refuges already established.

MOSQUITO CONTROL

Areas in New York, New Jersey, Delaware, Maryland, Virginia, Tennessee, Alabama, and California were surveyed to determine the effect of mosquito-control operations on waterfowl food resources or to permit recommendation of such methods as would be least injurious to wildlife. In some areas it was found that every effort was being made to protect the interests of wildlife, while in others this resource was being ignored. That there is need for mosquito

control to protect the population of large cities cannot be denied, but the partial drainage of valuable marshlands and deep ponds far removed from human habitation, with its lowering of water tables and development of impenetrable thickets of worthless baccharis and high-tide bush, is quite a different matter.

Investigations indicate that the destructive effects of mosquito-control operations on wildlife habitat have been caused chiefly by alterations in natural water levels beyond the limits that most of the desirable food plants can tolerate and by a lowering of water levels in ponds, thus destroying wigeongrass, sago pondweed, and other submerged plants by subjecting them to desiccation or injurious exposure to sun and wind. In many instances the lowering or excessive fluctuation of water levels as a result of ditching for mosquito control has led to the invasion of important marsh areas by undesirable plants, which rapidly displace species useful to waterfowl and other valuable forms of wildlife.

In cooperation with other interested Federal and State agencies the Bureau has initiated experiments in several localities to determine the effects of various mosquito-control methods in order that necessary work may be undertaken without needless damage to wildlife or its habitat. These experiments are concerned with studies of mosquito breeding in different types of ponds and marshes and of control measures that will not seriously interfere with the valuable flora and fauna. Recommendations have been made that water levels be adequately controlled where possible through the use of sluices, tide gates, and other means, and that mosquito breeding be checked by such biological means as the use of killifish and top minnows. In several instances these cooperative efforts have resulted in the preservation of valuable wildlife habitats.

The Bureau issued a leaflet (BS–17) on the Wildlife of the Atlantic Coast Salt Marshes, primarily for educational use in C. C. C. camps engaged in mosquito-control operations along the Atlantic coastal area.

LABORATORY STUDIES OF FOOD

Though the food-habits research staff spent more time in the Washington office this year than last, relatively few stomachs were examined because of the preparation of manuscripts for bulletins and leaflets. In addition to reexamining more than 200 game bird stomachs, however, the contents of stomachs of 790 birds, 283 mammals, and 43 reptiles were analyzed as well as 242 bird pellets and 437 collections of mammal droppings. In the Food Habits Laboratory at Denver, half the staff of which was transferred to the Washington office in the first quarter of the fiscal year, the stomachs of 68 birds, principally of crows collected on waterfowl-breeding grounds, and of 1,888 mammals, including 825 coyotes and 117 bobcats, were examined. The contents of the droppings of 44 mammals, including bears, wolves, coyotes, mountain lions, and bobcats, also were identified.

REPORTS ON THE FOOD OF BIRDS

One of the major accomplishments this year has been the completion of a detailed manuscript on the foods of game ducks in the United States and Canada. In this report all plants heretofore used or recommended as duck foods, as well as a number of hitherto unrecognized merit, are treated with respect to identification, value, parts eaten by ducks, environment, and propagation. It will be illustrated by drawings or photographs of the majority of the food species and accompanied by distributional maps. Manuscript for a technical bulletin on the food habits of the North American diving ducks, the third and last of the series treating the food habits of the ducks, also was prepared for publication.

Though it has not been possible to complete the projected bulletin on the food of the fish-eating birds, a general discussion of the role of the various species was prepared for mimeographing by the Bureau of Fisheries. An illustrated leaflet on Excluding Birds from Reservoirs and Fish Ponds was also submitted for publication.

A manuscript report was prepared on the food of the scaled quail—a southwestern game bird—for which 267 stomachs were examined. The analyses of 5,185 stomachs of the more familiar hawks were compiled and published as Circular No. 370, Food Habits of Common Hawks.

A set of 10 leaflets (BS–41 to BS–50), Fruits Attractive to Birds, treating the various native and extralimital fruits suitable for planting in 10 regions of the

United States, was published. Contributory to the widespread land-improvement work of the Department a mimeographed list of Plants Valuable for Wildlife Utilization and for Erosion Control has been distributed (Leaflet BS–19). A revised bulletin covering the winter feeding of wildlife, the subject of much correspondence, has been prepared.

Information on the food habits of species under arctic conditions was markedly increased by the examination of 48 stomachs collected between southern Hudson Bay and western Greenland in the summer of 1933. These, together with 63 previously examined, formed the basis of an article on the Food of Some Arctic Birds and Mammals collected by the Bartlett Expeditions of 1931, 1932, and 1933, published in the Journal of the Washington Academy of Sciences.

A leaflet (BS 30), Economic Ornithology and the Correlation of Laboratory and Field Methods, was issued, in which inadequacies in the exclusive use of either method are demonstrated and the fact stressed that the two can be employed to mutual advantage.

Among mimeographed leaflets issued in revised form to facilitate answering of correspondence were the following: Local Control of Magpies (BS–51), Directions for Preservation and Care of Material Collected for Food Habits Studies (BS–29), Planting for Wildlife in the Corn Belt (BS–14), and Planting for Wildlife in the Cotton Belt (BS–15).

FOOD OF MAMMALS

An account of the food of the coyote in an essentially wilderness area, based chiefly on examination of feces, was published as Circular No. 362, Food Habits of the Coyote in Jackson Hole, Wyo. A report on the food habits of the species, based on the examination of more than 13,000 stomachs, of which 8,300 were full enough to be used in deriving food percentages, is now in preparation. Nearly 1,000 stomachs of the bobcat also have been examined. Analyses of the food content of more than 500 stomachs of black-tailed, white-tailed, and Gunnison's prairie dogs were completed and summarized for a circular on the food of these species.

REPTILES AND AMPHIBIANS

The reference collection of photographs of North American amphibia and reptilia has been expanded considerably in the past year and now comprises pictures of 104 species and subspecies, including 7 species of salamanders, 12 of frogs, 7 of lizards, including the gila monster, the alligator, 60 species and subspecies of snakes, and 17 species of turtles. All the poisonous snakes and the majority of the harmless species indigenous to the area east of the Great Plains have now been photographed for use in illustrating a popular bulletin.

Through cooperation with the Forest Service, series of snakes have been collected for economic studies, as information on the food of most species has been lacking. A knowledge of the economic status of each form is needed for intelligent wildlife management.

COOPERATIVE FOOD-HABITS INVESTIGATIONS

In cooperation with the Bureau of Fisheries some 113 stomachs of the Alaska fur seal were examined.

During three surveys of the Tennessee Valley Authority area, the water impoundments were inspected, recommendations for the conservation of waterfowl resources were made, and the effect of mosquito-control operations upon waterfowl food plants was studied.

Stomachs of 3 Gambel's quail, 11 coyotes, and 1 deer, 20 pellets of the long-eared owl, and 4 lots of coyote droppings were examined for the National Park Service; and the following for the Forest Service: Stomachs of 4 ruffed grouse, 2 turkeys, 31 deer, and 3 elk, and 18 lots of mammal feces.

Cooperating with the Soil Conservation Service, the Bureau conducted preliminary wildlife surveys and supervised work in planting to improve waterfowl conditions in southeastern Washington and northwestern Oregon, aided in transplantations of beavers, and compiled available data on the food habits of North American rabbits, squirrels, and prairie dogs. In addition, stomach examinations were made of 11 bobwhites, 1 ruffed grouse, 3 ringnecked pheasants, 1 common crow, 7 small birds of different species, and 4 raccoons; and

analyses were made of 12 pellets of the burrowing owl, 41 of the barred owl, and 36 of the great horned owl.

A malady of ducks was investigated for the Colorado Fish and Game Department and diagnosed as lead poisoning. About 90 opossum, 22 bobcat, and 7 red fox stomachs, and 2 lots of coyote feces were examined for the Michigan Game Department. The cooperative ruffed grouse work was continued, 138 birds being examined for the New York Conservation Department and 158 for the Minnesota Ruffed Grouse Investigation. Some of the stomachs of hawks (59, largely goshawks), killed for bounty payment in Pennsylvania, were examined for the State Board of Game Commissioners. For the National Association of Audubon Societies the stomachs of 12 broad-winged hawks were examined as well as 4 pellets of the saw-whet owl, 52 of the long-eared owl, 16 of the short-eared owl, and 41 of the barn owl.

Besides food analyses for official cooperators of the Bureau, others, including those of 50 yellow-headed blackbird stomachs and 65 long-eared owl pellets from Iowa, and of several bobcat stomachs from Texas, were made for individuals. Identifications of seeds were made for the Cooperative Quail Study Association. An interesting archaeological problem was submitted by the University of Arizona, which requested the identification of hair used in five samples of cordage from caves being excavated in Arizona and New Mexico.

The National Park Service made possible a study of the effect of arsenical sprays on bird life in the Morristown (N. J.) National Historical Park. From an airplane the forest trees on a restricted area were sprayed with liquid lead arsenate. The infestation of canker worms was reported successfully controlled thereby, the kill averaging 100,000 larvae to the acre. The bird and other vertebrate life of the area appeared to be unaffected by the insecticide.

Six of the series of seven upland-game-bird management projects in which the Survey has been a cooperator have been continued this year through the interest of the operators. These areas were inspected, and suggestions were made as to improving the stands of various quail foods and for employing controlled burning to improve the areas with respect to food and cover. Though detailed reports have not been received from all of these, a comprehensive report was turned in on the Arnett project, a summary of which appeared as a mimeographed leaflet (BS–39), entitled "Report of the Arnett, Oklahoma, Experimental Quail and Prairie Chicken Management Project."

DEPREDATIONS INVESTIGATED

CROW-WATERFOWL RELATIONSHIPS

The preliminary field study of crow-waterfowl relationships, made in the summer of 1935 on Canadian breeding grounds, demonstrated that near the northern border of agriculture in Saskatchewan and Alberta at least there are areas in which the crow exerts a decided pressure on nesting waterfowl. Much of this may be attributed to the presence of an unusually dense crow population in close proximity to duck-nesting marshes, as the areas were selected with the view of studying this bird at its worst. The region in which the crow is sufficiently abundant to be a destructive factor, however, covers only a part (possibly one-sixth) of the highly productive waterfowl nesting areas of Canada and Alaska. The findings have been embodied in a report that has been prepared for publication. Subsequent field studies of the role of the crow on duck-nesting areas in the United States were commenced in May on Federal refuges in North Dakota.

WHITE-NECKED RAVENS, CROWS, AND JAYS

Complaints of white-necked raven depredations were again investigated in Texas and methods recommended for control. These are summarized in a mimeographed leaflet (BS–27) issued during the year under the title "A Cage Trap Useful in the Control of White-necked Ravens."

Studies of crow abundance in Oklahoma have demonstrated that the period from November to February is best for conducting control work, since the birds are then concentrated in their large winter roosts.

To aid farmers in Rocky Mountain States in preventing damage by jays in cornfields, a mimeographed leaflet (BS–26) was issued describing methods of control.

EUROPEAN STARLING

The introduced starling through its gregarious roosting habits continues to be a serious problem in municipal areas. Several proposed methods of combating the birds have been tried out under field conditions. The use of the highly toxic hydrocyanic acid gas is not feasible at roosts in metropolitan areas. Trapping was practiced at feeding stations with fairly good results. Shooting, although an efficient method, can hardly be recommended in metropolitan sections because of the danger to human beings and property. Information gleaned from these experiments, together with reliable material from other sources, will be assembled in a leaflet on the known effective means of combating objectionable roosts of starlings.

CROP DESTRUCTION BY BIRDS IN CALIFORNIA

Bird depredations on crops in California have exceeded those in any other State in numbers of species of birds involved, crops attacked, and damage done. Meadowlarks, which severely damaged young watermelons in the southern part of the State, and jays, a chronic cause of local injury to poultry, almonds, walnuts, and fruits, this year seem to have replaced the linnets (house finches) and horned larks as prime crop enemies. A manuscript describing methods of protecting crops from damage by horned larks has been prepared for the leaflet series. A 7-year cooperative study of the depredations of linnets, horned larks, English and crowned sparrows, red-winged blackbirds, California jays, and western crows has resulted in the issuance in mimeographed form of the first part of a cooperative manual entitled "Procedure and Methods in Controlling Birds Injurious to Crops in California." The bearing of the daily and seasonal movements of birds on crop depredations is now being studied by banding representatives of the injurious species. A manuscript reporting on the distribution, nesting range, and economic status of the tricolored redwing over the 5-year period 1931–36 has been completed.

PREVENTING GRAIN DESTRUCTION BY BIRDS

With a view to advising correspondents regarding methods of preventing destruction in grainfields by birds of various species, without destroying the birds themselves, a mimeographed leaflet (BS–13) was issued under the title "Protecting Grain Crops from Damage by Wild Fowl."

FOXES

In cooperation with the Commission of Game and Inland Fisheries of Virginia further studies were made of the status of the gray fox as a predator in upland game areas, with special attention to its relation to nesting bobwhite quail. In ascertaining the extent of the depredations a series of 42 bobwhite quail nests were located and kept under observation at the Camp Lee Game Refuge. Detailed food-habits studies of the gray fox were also initiated at Camp Lee to ascertain the degree to which foxes prey upon the birds.

ARMADILLO

Field studies of the relation of the armadillo to nesting bobwhite quail in Texas were resumed in June. In addition to field studies of real and dummy bobwhite quail nests, the laboratory examination of stomachs has been continued and the acceptance of eggs as food by captive armadillos has been tested.

FUR-PRODUCTION RESEARCH

DECREASE IN FUR ANIMALS CONTINUES

The majority of raw-fur collectors report receipts of raw furs much lower than in the previous year. At the end of this year the raw-fur market showed little carry-over, and no excess of raw furs was in sight. The trade in the United States is depending more and more upon foreign countries for raw furs and now uses more than twice as many foreign as domestic furs.

The present serious situation is largely the result of public indifference to fur-animal conservation and failure to appraise the importance of fur as a natural resource. There seems to be no policy of "live and let live" where fur animals are concerned. As the property of the people in the various States the natural resource in fur animals should be managed more uniformly for the benefit of all. By use of radio and other addresses, magazine articles, official publications, motion pictures, and exhibits, the Bureau has vigorously continued its efforts to impress on the public the necessity of restoring and conserving the fur animals if there is to be a future supply.

The culmination of these efforts was presented to the fur resources management section of the North American Wildlife Conference, held in Washington in February. The proceedings of this section, which were manifolded and given wide distribution to all associations and individuals interested, further demonstrated not only that the supply of fur animals is in jeopardy but also that many who realize that this is the case have no clear conception of its implications.

The Bureau addressed a letter to the conservation and game and fish commissions in the various States stressing the seriousness of the situation, requesting that further protection be given by the respective States to the fur animals in greatest need, and recommending that a close season be prescribed on martens, fishers, otters, and wolverines. Nearly half the States replied favorably. Several had already closed seasons on these valuable fur animals, and commissions in other States promised to recommend similar action to their legislatures. Further evidence of the serious condition of the fast dwindling fur resource was gathered from the replies received from the conservation and game and fish commissions. State after State, where various fur animals were previously found, report few or none of the animals at present. These reports have amply corroborated previous findings of the Bureau.

FUR-FARMING DEVELOPMENTS

The fur markets of the world during the past year handled more silver fox and mink pelts produced in captivity than in any previous year. The world's production of silver foxes is approximately 700,000 pelts, and the business continues to expand. The most striking developments, however, have been in mink farming. The number of farm-raised mink pelts has increased rapidly, and the prices paid were exceptionally good, in fact, the highest ever paid for mink pelts produced on farms. Such favorable conditions have naturally stimulated expansion in mink production.

Keen competition is forcing fur farmers to recognize that to increase the margin of profit they must improve the quality of fur and reduce production costs and overhead charges to a minimum.

The raising of rabbits for meat and fur showed a healthy growth during the year. The market for both of these products as well as for live animals for laboratory purposes was active. Angora rabbit production assumed the proportions of promotional development, and many unscrupulous schemes have been devised to persuade persons to engage in this enterprise, playing up the large profits possible from the sale of Angora wool. There is, however, no large market for this raw product. A mimeographed leaflet (BS–55), Pertinent Facts on the Angora Wool Rabbit, was issued during the year.

Technical information of value to fur conservationists, fur farmers, and rabbit producers was made available in several articles prepared for various fur-trade and fur-farming periodicals of the United States and foreign countries. To assist in replying to correspondence on the various subjects, several of these articles and others of value to producers of fur animals were issued by the Bureau in its mimeographed series of leaflets. The following titles not mentioned elsewhere in this report may be here noted: Fur Resources—the Stepchild of Conservation (BS–25), Raising Badgers in Captivity (BS–32), Raising Raccoons (BS–34), Raising Muskrats (BS–35), Publications on Fur and Fur Animals (BS–36), Raising Guinea Pigs (BS–52), and Marking Wild Animals for Identification (BS–57).

TRENDS IN SILVER FOX FARMING

A study made during the year of silver fox pelt production in the United States as compared with foreign countries showed that Canada and the United States are producing annually from 350,000 to 400,000 pelts; Norway, Sweden, Netherlands, Denmark, Union of Soviet Socialist Republics, Germany, England,

France, Switzerland, Japan, and South America together 300,000. After a thorough survey of the best statistics and data available, the results were summarized and made available to the various fur-farming and fur-trade periodicals of the United States and Canada.

An exhaustive study of the silver fox pelt markets in the United States and Great Britain covering a 5-year period (1932–36) was made to determine the trends in classification and prices according to various percentages of silver in the pelts. Results of this survey showed that about one-third of the American offerings in 1936 were full silver skins, a relative increase of 235 percent during the 5-year period. The prices obtained in the United States for full silver pelts were 50 percent higher than in Great Britain. On the basis of full-silver prices there was a reduction of about 12 percent in value for each of the classes of half, one-fourth, and dark silvers. The results of this study were set forth in a mimeographed leaflet (BS–58) entitled "Classification and Price Trends of Silver Fox Skins."

Sex, age, time of pelting, and classification of pelts are factors that materially influence the price received. To obtain more accurate and comprehensive information on the relative effect that each of these factors has on price levels a special study was made of the records kept by one of the largest fox farms in the world, a firm that sold 10,000 silver fox pelts during the 1935–36 season. The information obtained is being prepared for publication and should be of considerable value not only to the fur trade but also to fur farmers in guiding future operations.

RABBIT-FUR STUDIES

DOMESTIC RABBITS

Studies of the various factors that influence the quality of domestic-rabbit fur, begun in 1932, were completed this year and a résumé of the findings was presented to the annual convention of the American Rabbit and Cavy Breeders Association. Heredity, feed, age, and time of pelting all are found to have an influence on the quality of the fur.

The pelts of 6-pound rabbits from 80 to 130 days of age showed unprime areas where the hair was in the process of shedding, and a high percentage of these skins was unfit for furriers' purposes. About 16 percent of 416 white rabbit pelts graded as no. 1 furriers. Some of the best skins were produced in each month of the year, but the majority of the good skins were produced in the colder months. These findings further substantiated the Bureau's various recommendations that rabbit producers should concentrate their efforts on the economical production of rabbit meat, with the fur a secondary consideration, although every effort should be made to produce as fine a pelt as possible. Other recommendations for rabbit raisers have been issued during the year as mimeographed leaflets; Feed Cost of Producing Young Rabbits to Weaning Age (BS–21), Feed Requirements in Raising Weaned Rabbits to a Weight of 6 Pounds (BS–22), Feeding Schedule for Rabbits (BS–28), Average Weight of Rabbits at Weaning Age (BS–31), and Periodicals on Rabbits and Cavies (BS–56).

WILD RABBITS

The increased demand for rabbit fur during the past year resulted in a 50-percent rise in the prices. This was an incentive for rabbit-skin dealers to investigate the possibilities of utilizing jack rabbit and cottontail skins for the manufacture of trimmings and fur garments. Arrangements were made with the field force working in the Great Plains shelterbelt area to furnish a supply of rabbit skins taken at approximately 3-week intervals, and as a result skins of 150 whitetails, 109 blacktails, and 171 cottontails (of both sexes) taken in North Dakota, Nebraska, and Oklahoma were sent to Washington for grading and appraising. Some of the best of the jack rabbit skins were dressed and some were dyed, but the results were unsatisfactory. Experts in the fur trade placed no value on them for furriers' purposes and stated that the wild rabbit skins from Australia and New Zealand were much superior in quality.

A number of jack rabbit and cottontail pelts are now being examined and treated to determine the relative value of the fur as compared with that generally used in the manufacture of felt hats. This is a cooperative study undertaken by the Bureau with the research department of a hat-manufacturing company.

COOPERATIVE RESEARCH WORK

EMBRYOLOGICAL INVESTIGATIONS

Recognizing the importance of embryological research in the development of the best strains of fur animals, the Bureau entered into a cooperative agreement in 1930 with the Carnegie Institution of Washington for conducting investigations in this field. The reproductive organs of male and female coyotes, wolves, mountain lions, bobcats, muskrats, rabbits, and other fur animals were collected and sent to Johns Hopkins University for preservation and study. During the past year an embryologist was employed by the Bureau to devote his entire time to the study. Additional material collected during the year made possible a more detailed study of problems involved.

Microscopic studies of the reproductive organs of coyotes obtained during various seasons of the year were made to determine the period of sexual activity. Laboratory studies were supplemented with other available data pertaining to embryos and suckling young as reported by predatory-animal hunters and field naturalists of the Bureau. The results of this research, showing that coyotes produce only one litter a year and that they are sexually active from January 1 to March 31, have been prepared for publication. Important findings of this investigation were presented at the annual meeting of the American Society of Mammalogists, in Philadelphia, Pa., in May.

The muskrat-breeding season on Maryland marshes was unusually delayed by the past winter's unprecedented cold weather, and this prevented completion of the collection of a series of eggs and embryos before the close of the trapping season. Considerable embryological material of jack rabbits and cottontails has been collected and preserved for later detailed study.

FUR-STORAGE EXPERIMENTS

Experiments undertaken in cooperation with local fur concerns have been continued to determine the relative values of storage methods and their effects on dressed furs and linings. Furs in storage for 3 years have been examined by fur experts and their opinions recorded. Officials in the Bureau of Standards are cooperating to determine whether any differences in color, texture, and chemical composition might be demonstrated by mathematical methods. Furs that have been in storage for 1 year will be held for later observation.

KARAKUL FUR

For a quick and accurate determination of the progress thus far made in the production of merchantable Karakul lamb pelts, all the lambs, both rams and ewes, born this year at the National Agricultural Research Center, Beltsville, Md., were killed at 4 days of age and the pelts taken. These included 37 purebred Karakuls, 25 Karakul-Highland crosses, and 23 Karakul-Corriedale crosses. The skins were first graded by Bureau representatives and then checked by fur-trade experts. The information obtained relative to quality and value, as compared with skins produced in other countries, should be useful in formulating policies in the breeding operations of this flock. This work is conducted in cooperation with the Bureau of Animal Industry.

FUR ANIMAL EXPERIMENT STATION

At the close of the fiscal year Congress appropriated $21,500 to purchase the land near Saratoga Springs, N. Y., on which the United States Fur Animal Experiment Station is located and also to construct a house for the director and fence the property. This will make it possible to conduct the work on a more extended and satisfactory basis. The new director of the station has spent considerable time in organizing and systematizing the experimental work and in tabulating and summarizing all previously completed experiments.

During the year the director addressed various civic organizations and fur breeders' associations and arranged for local publication of 17 articles dealing with the past history of the station and current problems of fur farming. In addition, two leaflets dealing principally with the work of the station were issued: What Shall We Feed Our Pelters (BS–20) and An Automatic Drinking Fountain for Minks (BS–40), and have been much appreciated by fur farm-

ers. The station is open to the public 1 day each week from July 1 to December 1, and among the visitors were persons from Cuba, Norway, Germany, Alaska, and Canada.

MINKS

Though the station had obtained valuable information on general feed requirements, methods of management, and breeding activities of minks in years previous, the first definitely controlled experiments were completed this fiscal year. Four small groups of weaned minks were fed the experimental rations, and their weights taken biweekly until pelting time. Tankage and liver meal as a substitute for half the raw-meat portion of the ration for mature minks from midsummer until pelting time gave unsatisfactory results in gains in live weights as well as in growth and quality of fur produced. Detailed information on the results of this experiment was made public in a mimeographed leaflet (BS-60), Feeding the Weaned Minks.

An experiment on feeding mature female minks a simplified dry mixture during breeding, gestation, and whelping periods was completed at the close of the year. The number of young produced on the simplified ration was not so satisfactory as on the more complete ration.

FOXES

The fox experimental work this year gave a second year's result on the value of tankage 5 parts and liver meal 1 part as a complete substitute for the raw-meat portion of the ration usually fed to both mature vixens and males during summer and fall. The results obtained with the mature vixens bear out to a marked degree the findings of 1934, that there was no appreciable difference between the control and the test vixens in general health, in quantity of food consumed, or in the rate of shedding of old fur and growth of new. The feed cost was about 30 percent cheaper for vixens fed the packing-house byproducts. How this summer feeding may affect subsequent reproduction periods has, of course, not yet been learned. The male foxes did not do so well on the test ration as did the vixens, but the reason was not apparent.

Tankage and liver meal as a complete substitute for the raw-meat portion of the ration was tested with pups from weaning until pelting time. Though a complete summary of this experiment is not yet available, in general it may be said that the health of the test pups was not so good as that of the control pups, since it became necessary to remove two of them from the experiment in early October to prevent death. These two pups recovered when put upon a heavy raw-meat ration. Though the immediate feed cost is reduced by using packing-house byproducts, it is questionable economy if the results are detrimental to the foxes.

Three vixens after whelping were put on drastically modified rations as a preliminary test to determine how abnormal the rations could be made. One of them was gradually accustomed to a ration composed principally of dried skim milk and finely ground yellow corn meal, but this test showed such unsatisfactory results that the ration was continued only a few days. Two others were fed rations containing finely ground corn meal as almost the exclusive cereal, combined with raw meat in one case, and packing house byproducts in another. The results were quite unsatisfactory. The study was continued in a somewhat modified form after the pups were weaned, but the final results have not yet been summarized.

An experiment testing the effects of a somewhat simplified cereal mixture in rations having 60 and 40 percent, respectively, of raw meat was completed at the close of the year. A preliminary review of the results shows no appreciable difference in breeding performance and apparently no difference in milk production and general health. The results will be prepared for publication.

A fox-feeding experiment was begun during the latter part of the year to compare beef meal (4 parts) and liver meal (1 part) with the tankage and liver meal in the same proportion but supplemented with a small quantity of raw meat in the summer maintenance of mature foxes. The study of the relative value of beef meal and liver meal as a complete substitute for raw meat in the ration fed weaned pups during the summer is being continued for a second year.

Some preliminary work was done on artificial insemination with foxes. This will serve as a basis for further tests to be undertaken as soon as breeding animals are available.

All the cross-bred foxes at the station were pelted last winter. They had served their purpose in the comprehensive study of determining the genetic factors causing silvering. It was decided that by concentrating on silver foxes selected for uniformity of breeding, information on the causes of tinge could be more adequately studied and that comparative results of experimental feeding could be more accurately analyzed.

MARTENS

Of the six female martens kept at the station, only two produced litters. In an effort to increase their productivity changes were made in the rations by increasing the raw-meat content and other nutritive ingredients. This change in diet was made during the fall and spring, but as martens pair in July and August it had no direct effect upon the breeding efficiency this year.

RABBIT EXPERIMENT STATION

Visitors from 24 States and from Alaska, Canada, Cuba, Germany, Chosen, and New Zealand inspected the experimental work in operation at the United States Rabbit Experiment Station, Fontana, Calif., to obtain definite information on rabbit production in this country. The station provides facilities for general meetings of rabbit producers and local rabbit clubs in the southwestern part of the United States.

Fundamental research as well as experiments conducted for practical breeders have been projected along breeding, feeding, and management lines. The records kept over a period of several years have been a fruitful source of accurate information on the various problems encountered. A study of the kindling records of more than 2,000 New Zealand litters has established the fact that February and March are the months in which the highest breeding efficiency is obtained under southern California conditions. The lowest efficiency is in fall matings. It was found also that as the maximum temperature rises above 75° F., the breeding potential of the does is reduced. This study also revealed that 45 percent of the litters were kindled on the thirty-first day after mating and 41 percent on the thirty-second day. Records show that does breed at any time when in good physical condition, not in heavy molt, and free from disease, and that age is not a factor affecting the duration of pregnancy. A system of handling does at mating time that has assured 100-percent matings was developed. The percentage of does that kindled after being thus handled was as high as that of does released for mating in the usual manner, thereby resulting in a greater number of litters from a given number of does. These findings were published in the various rabbit journals and should be of much practical value to rabbit raisers.

SUPERIOR MEAT-PRODUCING RABBITS

In a definite breeding program pursued for selecting and reproducing rabbits possessing superior germ plasm, a marked variation has occurred and some exceptional production records have been obtained. In two litters of a single 10-pound doe 63.5 pounds of choice fryer rabbits, averaging 4.88 pounds at 8 weeks of age, were produced. This record was made in 175 days, beginning with the breeding date of the first litter and including the weaning date of the second. This doe produced the equivalent of 635 percent of her live weight in fryer rabbits, or an average of 0.36 pound of meat for each day she was on test.

FEEDING EXPERIMENTS

Feeding rabbits by means of selective self-feeders has indicated consistently that no advantage is derived from providing rolled grains, such as barley, wheat, or oats. The rabbits have shown a preference for whole grain, and it has actually required less feed in whole grains to produce a pound of fryer rabbit. Young rabbits with their mothers self-fed with whole grain, pelleted plant protein meal, alfalfa hay, and green feed show an average increase in weaned weight at 56 days of 33 percent over comparable litters that have been fed a restricted concentrate consisting of milled grains with alfalfa hay and green feed. This increase has been due very largely to the fact that the rabbits consume a higher percentage of concentrates when self-fed, about 2 pounds of grain for each pound of roughage.

It was also found that self-fed rabbits consumed more of the protein portion of the ration than was formerly considered necessary. The station now recommends a concentrate mixture with a nutritive ratio of 1:4 for mature bucks, resting does, and developing bucks and does. A concentrate mixture having a nutritive ratio of 1:3 is being recommended for does suckling litters.

Through the self-feeder studies it has been demonstrated that rabbits, of their own choice, consume wheat bran to the extent of only 2½ percent of the concentrated portion of the ration and that these rabbits thrive as well as those fed a larger quantity. Since the cost of a pound of digestible nutrients in wheat bran is considerably higher than that in cereal grains, restricting bran in the ration will effect a considerable saving in feed costs.

Experimental work at the station has demonstrated that rabbits are highly efficient meat-producing animals. Self-fed litters require only approximately 2 pounds of concentrates, 1 pound of alfalfa, and one-half pound of green feed to produce 1 pound live weight, information that should be an important factor in developing the rabbit business on a more substantial economic basis and thus in making this animal more popular for meat production. In order that rabbit breeders might learn the results of feeding experiments as soon as possible, reports of findings have been mimeographed from time to time and distributed among them.

FEEDING IN RELATION TO BLOAT

Studies of bloat in rabbits have been intensively pursued during the year in an endeavor to determine what influences various kinds of feed have on mortality from this cause. Several hundred animals are maintained in an experimental group for the study. Neither rolling nor soaking cereal grains nor pelleting the concentrate and roughage part of the ration has been found a factor in controlling the mortality, nor has including iron or copper in the ration. Extensive experimental work has failed to demonstrate that moldy alfalfa hay is a factor in causing bloat. This is important to the industry, since breeders heretofore have spent a great deal of time while cutting hay in removing any that showed indication of mold. Naturally clean hay is preferable, but even though moldy hay has a lower nutritive value than choice hay it can be fed to prevent waste. It has been demonstrated that the grain, pelleted protein supplements, green feed, or alfalfa hay fed to rabbits are not a direct cause of bloat. Although nothing definite as to the direct cause has yet been discovered, the results obtained from experimental feeding have been of considerable aid to rabbit breeders. The feeding studies will be continued to determine, if possible, whether certain feeds or combinations are responsible for this troublesome condition in rabbitries.

RESEARCH IN DISEASE CONTROL

The examination of great numbers of animals that have died from disease is gradually building up a fairly complete picture of the principal causes of natural losses in wildlife. Based on this composite information, collected from many sources in connection with planned research projects, a working knowledge has been obtained of the type of diseases frequently responsible for destroying valuable wild species as well as causing high death rates on fur and game farms.

FUR-ANIMAL DISEASES

Among fur animals, especially silver foxes and minks, the several diseases formerly classed under the general term "distemper" have received further study. It has been established that several filtrable-virus diseases transmitted either by sick animals or by apparently healthy carriers are responsible for widespread epizootics among these animals when suitable contact is afforded. Studies have shown that these diseases, generally referred to as distemper and encephalitis, may remain in a relatively innocuous state in a more or less immune group of animals for a long period and suddenly become highly virulent upon access to fresh, previously unexposed subjects. The phenomenon of increased virulence of infectious organisms in the presence of fresh hosts has been especially evident in the filtrable-virus diseases of fur animals.

Studies of these conditions in progress in the Bureau's laboratories, as well as in cooperation with the University of Minnesota and fur ranchers, are continuing. Pens for experimental animals used in disease-transmission tests and

experiments with feed poisoning, so frequently encountered on fur farms, are also being constructed at the National Agricultural Research Center, Beltsville, Md., for the purpose of making these investigations more effective. Losses from disease are important on fur farms, and many fur farmers have cooperated with the Bureau. Officially owned equipment, however, must be far removed from the commercial fur-farming enterprises, so that final tests may be conducted without jeopardizing valuable privately owned breeding animals.

GAME-BIRD DISEASES

Efforts have been redoubled to learn the origin and identity of abnormal conditions causing losses in wild game birds. The severe epizootics occurring periodically among bobwhite quail, popularly referred to as "quail disease", have been shown to be due to a definite bacterial organism, *Corynebacterium perdicum*. A preliminary report on this was made at the meeting of the North American Wildlife Conference held in Washington in February.

Bird pox also is being studied in its relation to the health of game birds. The chickenpox strain of the virus has been observed to cause pronounced lesions in quail, but the milder strain of pigeon pox virus tested has caused no pathology of significance. These tests are to be carried out in much greater detail, as field naturalists have reported more or less extensive losses from pox infections.

A comprehensive report of investigations of diseases of game birds has been prepared for publication, and to promote closer cooperation between field agencies and laboratory workers a manuscript has been prepared giving suggestions to field biologists for making post-mortem examinations.

WATERFOWL LOSSES

During the winter months numerous reports of losses in waterfowl along the Atlantic coast were received by the Bureau. Upon investigations many proved to be due to starvation and oil pollution in conjunction with heavy parasitism. No success has as yet been attained in reducing deaths from parasitism and insufficiency of feed during severely unfavorable weather. Various groups of officials connected with the administration of municipalities and industrial plants have been urged to effect better regulation of oil disposal.

Of special significance is the research being conducted with a view to developing a form of shot for wild-fowling that will not cause lead poisoning when picked up and eaten by the birds. Progress has been made through cooperation with the University of Minnesota to the extent of producing an alloy that readily disintegrates and passes through the digestive tract of birds so rapidly that little toxic action is experienced. This research is described in detail in a mimeographed monthly report to the Minnesota State Conservation Department prepared jointly by the University of Minnesota and this Bureau.

UPLAND-GAME FLUCTUATIONS

Intensive studies have been made in the North Central States on the more prominent game species subject to periodic fluctuations in abundance. Pursuing lines of research reported on during previous years in studying the specific causes of loss in snowshoe hares and grouse the investigators noted a condition of great significance recently in cooperative research with the University of Minnesota. In hares dying in great numbers during these periods of decline pronounced changes were observed in the chemistry and cellular structure of the blood in conjunction with functional changes. Efforts are being made to learn the underlying cause that predisposes the animals to these gross abnormalities.

ACQUISITION OF LANDS FOR REFUGES

A continuation of the program of refuge-land acquisition was made possible by act of Congress approved June 15, 1935, making $6,000,000 available for the purchase or acquisition otherwise of areas adapted to the protection of migratory waterfowl and other forms of wildlife.

In order to prosecute this enlarged responsibility effectively, the United States was divided for refuge-acquisition purposes into four regions: Region 1, with headquarters at St. Louis, Mo., the North Central States; region 2, headquarters San Antonio, Tex., the South Central States; region 3, headquarters Ogden,

Utah, the Western States; and region 4, the Eastern States, with administration under the Washington office. Experienced examiners and negotiators were engaged on prospective areas within these States and from their efforts recommendations were presented to the Migratory Bird Conservation Commission for consideration and approval at meetings held in August 1935 and in January and May 1936, involving 727,900 acres in 49 units, at a total acquisition cost of $3,982,579. During the year, 1,827 miles of refuge boundary, 2,303 miles of necessary auxiliary lines, and 19 miles of level lines were surveyed on refuges being purchased under emergency funds. Survey descriptions and accurate maps for all surveys completed are being prepared practically concurrently with the completion of the field work.

Appraisals and negotiations have been continued for lands on the units being acquired under the emergency funds of the previous year. Judicial proceedings for the acquisition of tracts not otherwise obtainable were also instituted within numerous refuges where lands have been or are in the process of acquisition with emergency funds. Some of these cases are still pending in the courts.

The language of the authorization for the purchase of refuge lands having been broadened to include lands adapted to wildlife other than migratory waterfowl, important additions have been obtained for the Elk Refuge in Wyoming.

Table 2 indicates the units acquired, optioned, or in process of acquisition during the year, with the total acreage involved. One of the most important acquisitions in the program was the Okefenokee Swamp, in Georgia. This famous wildlife haunt has long been regarded as ideal for refuge purposes. It is the largest single addition to the refuge system and was acquired only after prolonged negotiations and at a figure that netted the United States a considerable saving under the price originally asked.

Among other new migratory-waterfowl refuges optioned or acquired during the year, or in process of acquisition, were the following: Bombay Hook, Del., a Delaware Bay waterfowl resort much frequented by brant; Camas, Idaho, a nesting refuge in the Snake River flight lane; Green Bay, Iowa, a waterfowl concentration point in the Mississippi Valley flyway; Moosehorn, Maine, one of the greatest woodcock concentration grounds in the country; Tamarac, Minn., a great nesting area in Minnesota's best waterfowl-producing section; Yazoo, Miss., a wintering ground completing the program of acquisition in the lower Mississippi Valley flyway; Mingo, Mo., a famous waterfowl resting marsh; Ruby Lake, Nev., a fine waterfowl area of great natural beauty; Bitter Lake, N. Mex., the outstanding waterfowl area of the Pecos Valley flyway; Bosque del Apache, N. Mex., a strategic wildlife concentration and wintering point in the middle Rio Grande Valley; Pea Island, N. C., an indispensable wintering ground for Canada geese and American brant, and the southernmost wintering ground of the greater snow goose; and Willapa Harbor, Wash., a strategic coastal concentration point and wintering ground for waterfowl, and essential to the conservation of the black brant.

TABLE 2.—*Lands for refuges acquired or in process of acquisition during the fiscal year 1936 under the Migratory Bird Conservation Act program and with emergency funds*

State and county	Refuge	Under Migratory Bird Conservation Act program			Under emergency funds			Acquired other than by purchase	Total	Acquired in previous years
		Acquired by purchase	Pending title conveyance	Total	Acquired by purchase	Pending title conveyance	Total			
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Arkansas:										
Mississippi	Big Lake					80	[1] 80		80	9,309
Desha, Monroe, Phillips, and Arkansas.	White River				24,924	33,071	[2 3] 57,995		57,995	39,721
California: Glenn and Colusa	Sacramento					10,775	[4] 10,775		10,775	
Delaware: Kent	Bombay Hook		8,277	8,277					8,277	
Florida: Jefferson, Taylor, and Wakulla	St. Marks	1,237	5,485	6,722		10,653	[2] 10,653		17,375	35,663
Georgia:										
Charlton, Clinch, and Ware	Okefenokee		296,000	296,000					296,000	
Chatham	Savannah River (see also South Carolina).		875	875	2,574	1,462	[2] 4,036		4,911	424
Idaho: Jefferson	Camas		8,372	8,372					8,372	
Illinois: Mason	Chautauqua					2,353	[3] 2,353		2,353	2,053
Iowa: Lee	Green Bay		5,000	5,000					5,000	
Louisiana:										
Plaquemines	Delta		31,208	31,208		8,000	[2] 8,000	[5] 900	40,108	
Cameron and Jefferson Davis	Lacassine		7,510	7,510		22,304	[2] 22,304		29,814	
Cameron	Sabine					137,233	[2] 137,233		137,233	
Maine: Washington	Moosehorn		10,965	10,965					10,965	
Michigan: Schoolcraft	Seney		42,561	42,561	3,958	2,110	[2] 6,068	[5] 936	49,565	9,906
Minnesota:										
Aitkin	Rice Lake		1,359	1,359		7,243	[2] 7,243		8,602	
Cottonwood	Talcot Lake							[6] 80	80	
Becker	Tamarac	5,049	16,011	21,060				[5] 40	21,100	
Marshall	Mud Lake					52,713	[2] 52,713		52,713	
Winona (for headquarters warehouse)	Upper Mississippi	1		1					1	142,930
Mississippi: Washington	Yazoo		17,663	17,663					17,663	
Missouri:										
Stoddard	Mingo		15,353	15,353					15,353	
Holt	Squaw Creek	213	720	933	4,027	918	[2 3] 4,945		5,878	1,403
Chariton	Swan Lake		5,553	5,553	1,520	3,400	[2] 4,920		10,473	
Montana:										
Phillips	Lake Bowdoin					640	[2] 640	[5] 15,400	16,040	
Sheridan and Roosevelt	Medicine Lake				3,355	10,382	[2 3] 13,737	[5] 301	14,038	9,672
Beaverhead	Red Rock				11,319	20,776	[2] 32,095	[5] 1,196	33,291	
Nebraska:										
Garden	Crescent Lake					1,847	[2] 1,847		1,847	40,782
Cherry	Niobrara		375	375	2,232		[2] 2,232		2,607	15,288
Do	Valentine				41,286	17,655	[2 3] 58,941		58,941	2,120

Nevada:										
Clark and Lincoln	Desert Game							[5] 2,022,000	2,022,000	
Humbolt and Washoe	Charles Sheldon							[5] 528,794	528,794	30,441
Elko and White Pine	Ruby Lake		28,481	28,481					28,481	
New Mexico:										
Chaves	Bitter Lake	320	9,808	10,128					10,128	
Socorro	Bosque del Apache		55,886	55,886					55,886	
North Carolina:										
Hyde	Lake Mattamuskeet		529	529					529	49,925
Dare	Pea Island		7,206	7,206					7,206	
North Dakota:										
Stutsman and Foster	Arrowwood				3,979	3,514	[2] 7,493		7,493	5,813
Bottineau and McHenry	Lower Souris		8,724	8,724	25,385	7,979	[2 3] 33,364	[5] 80	42,168	15,190
Burke and Ward	Des Lacs		40	40	3,338	5,383	[2 3] 8,721	[5] 87	8,848	7,275
Walsh	Lake Ardoch					291	[7] 291		291	
Burleigh and Kidder	Long Lake					586	[7] 586		586	6,462
Mountrail and Burke	Lostwood		1,524	1,524	4,940	13,114	[2] 18,054	[5] 199	19,777	4,065
Sargent	Storm Lake					2	[7] 2		2	
Do	Tewaukan					80	[7] 80		80	
Renville and Ward	Upper Souris		961	961	21,740	2,173	[2 3] 23,913	[5] 120	24,994	5,499
Oregon:										
Harney	Malheur (Blitzen unit)		1,445	1,445					1,445	65,000
Do	Malheur (Malheur unit)		1,674	1,674	3,162	3,768	[3] 6,930		8,604	87,153
Lake	Hart Mountain		25,659	25,659				[5] 469,877	495,536	
South Carolina:										
Charleston	Cape Romain		3	3	5,191		[2] 5,191		5,194	32,019
Jasper	Savannah River (see also Georgia)		400	400	825	2,600	[2 3] 3,425		3,825	3,237
South Dakota:										
Charles Mix	Lake Andes	19		19	11		[2] 11		30	310
Bennett	Lacreek				1,192	3,402	[2 3] 4,594		4,594	4,128
Brown	Sand Lake				11,042	5,697	[2 3] 16,739	[5] 80	16,819	2,916
Day	Waubay	157	388	545	1,823	1,437	[2 3] 3,260		3,805	113
Tennessee: Lake and Obion	Lake Isom					1,581	[2 3] 1,581		1,581	16
Texas: Bailey	Muleshoe		2,157	2,157		3,654	[2] 3,654		5,811	
Utah: Box Elder	Bear River		3	3		15,519	[3] 15,519		15,522	48,697
Washington:										
Spokane	Turnbull		5,969	5,969					5,969	
Pacific	Willapa Harbor		1,643	1,643					1,643	
Wisconsin: Buffalo and Trempealeau	Trempealeau		5,404	5,404					5,404	708
Wyoming: Teton	Elk Refuge		7,979	7,979				[5] 3,082	11,061	4,518
Total		6,996	639,170	646,166	177,823	414,395	592,218	3,043,172	4,281,556	[9]

[1] National Industrial Recovery Act.
[2] Federal Emergency Relief Administration and Resettlement Administration fund.
[3] $1,000,000 fund provided by Executive Order No. 6724, dated May 28, 1934.
[4] $950,000 fund, a substitute for Executive Order No. 6724.
[5] Set aside by Executive Order or Proclamation.
[6] Acquired by gift.
[7] North Dakota land purchase fund.
[8] Held under lease.
[9] Total omitted, as entries in column are for only those refuges on which acquisition work was involved during the year.

MIGRATORY WATERFOWL RESTORATION

The second year of the national program of migratory waterfowl restoration was made possible by the $6,000,000 appropriation mentioned. The major activities included a program of reconnaissance leading to the location of new and desirable refuge areas to fill in existing gaps, the development and biological reconditioning of the areas upon their acquisition, and the organization of a trained personnel. After competitive civil-service examinations selections were made of men of excellent training and potentialities, both from the standpoint of practical administration and of practical research production, in the interests of maintaining the refuges on the highest possible plane.

REFUGE RECONNAISSANCE AND IMPROVEMENT WORK

The personnel engaged in reconnaissance and habitat improvement, having a knowledge of migratory waterfowl and their food and cover requirements, make explorative surveys along the main migratory waterfowl flyways and select areas that show the best potentialities for development. They see that each area qualifies in regard to abundance of available food and possibilities of restoration, check its previous waterfowl history and its strategic location with reference to main flyways and points of overshooting, and insure that the area is free from duck sickness and other wildlife maladies.

After the areas have been selected and the hydraulic developments accomplished, there follow the planting of waterfowl foods, reforestation and erosion control, enumeration of the waterfowl (which is becoming increasingly important in controlling the annual kill), introduction of nesting islands, grazing, cover, and fire control, observations for eliminating disease conditions, and investigations for increased production of wildlife.

During the past year attention has been given to the immediate biological rehabilitation of all the refuges in the program. To this end 61,984 pounds of seeds, tubers, and rootstocks of the principal aquatic duck foods were gathered and disseminated for propagation to refuges most deficient in essential stocks. As a result, within a year after the land was purchased, nesting birds found excellent food and cover conditions, and both nesting and brood counts show that in the summer of 1936 in many instances the refuges were already carrying the maximum number of nesting birds.

Particular attention was given to important wintering grounds in the Southeastern States and to the area from Chesapeake Bay north to Maine, in order to locate the most desirable sites for filling gaps in the refuge system.

After several months of intensive studies along the Texas coast wintering grounds, excellent refuge sites were selected that will protect a number of birds threatened with extinction. Reconnaissance work resulted in the selection of other desirable refuge sites in the important dry-farming area of the Texas-Oklahoma Panhandle and contiguous areas in Kansas, Colorado, and New Mexico, as well as in California, Oregon, Washington, Idaho, Montana, Wyoming, North Dakota, and South Dakota, and in Iowa, Missouri, Mississippi, Indiana, and Wisconsin.

An increasingly important feature of this work has been the consultation service provided for both State organizations and private conservationists with respect to the location and biological rehabilitation of refuge areas. Expert service was given in the designation of suitable trees, shrubs, and aquatic plants best suited for the production of wildlife foods in particular geographical areas, and in some instances seeds necessary for a successful starting of the plantings were provided.

NORTH DAKOTA EASEMENT REFUGES

Completion within the year of an extensive program of small refuge development in North Dakota was made possible by an allotment from the Works Progress Administration of $286,240. Thirty-two refuge areas in 21 counties were reserved for the purpose by means of gratuitous easements. These grant to the Government perpetual right to impound water, to fence, to erect refuge markers, and otherwise to develop the areas to make them habitable and attractive to migratory waterfowl.

The devastating droughts in 1933 and 1934 reduced or almost eliminated crop production in large sections of North Dakota and served to make an already water-conscious citizenry doubly appreciative of the advantage of conserving water resources. To facilitate the Bureau's conservation program, the State

legislature enacted laws authorizing and directing the several counties to exempt from taxation all inundated refuge lands and to waive the collection of recording and filing fees for document required by the United States in connection with the program. Further legislation gave to the United States easements on State-owned land for construction, water impoundment, and law-enforcement purposes. Private landowners supported the program enthusiastically, and as they granted the necessary perpetual easements cheerfully and gratuitously, the cost to the Government was negligible. In a total of 57,932 acres it was necessary to purchase only 1,039, and the only other costs incident thereto were those to obtain the easements, title-status reports, and releases of mortgages, liens, and adverse claims. A list of the refuges thus acquired, together with their locations and areas, is given in table 3.

TABLE 3.—*Bird refuges established in North Dakota in 1935–36 by gratuitous easements to the Federal Government*

Refuge	County	Water area	Total area	Refuge	County	Water area	Total area
		Acres	*Acres*			*Acres*	*Acres*
Lake Alice	Ramsey	3,420	5,279	Lords Lake	Bottineau and Rolette.	753	1,916
Appert project	Emmons	85	1,120				
Ardoch Lake	Walsh	1,150	2,985	Lost Lake	McLean	86	960
Billings Lake	Cavalier	140	760	Maple River	Dickey	100	1,120
Bone Hill Creek	La Moure	35	640	Nason project	Grand Forks	40	359
Buffalo Lake	Pierce	640	1,903	Lake Nettie	McLean	410	1,800
Canfield Lake	Burleigh	218	310	Pleasant Lake	Benson	487	959
Clouds Lake	Sargent	160	840	Sheyenne Lake	Sheridan	469	812
Lake George	Kidder	1,385	3,278	Shirek project	Walsh	70	480
Halvorson project	McHenry	40	399	Shirk project	McKenzie	40	400
Hanson project	Emmons	20	640	Storm Lake	Sargent	194	677
Hutchinson project.	Kidder	292	449	State Land project.	Emmons	45	640
Johnson Lake	Nelson and Eddy.	800	1,726	Lake Tewaukan	Sargent	1,436	3,761
				White Lake	Slope	158	960
Kellys Slough	Grand Forks	130	903	Willow Lake	Rolette	1,201	2,784
Klabunde project	Emmons	21	480	Wood Lake Marsh	Benson	42	545
Lawler project	do	42	495				
Long Lake	Burleigh	13,216	17,552	Total		27,325	57,932

Each site was selected because of its individual value primarily for wildlife and water conservation and secondarily for flood and soil-erosion control as determined by field surveys, and attention was given the problem of utilizing submarginal or low-grade lands as reservoir sites.

The construction work was performed entirely with relief labor except for the limited supervisory personnel. The water-impoundment structures were confined to such types as provides maximum storage benefits with minimum hazards. Adequate spillways were provided on all water-impoundment structures, and all dams and dikes were riprapped to withstand wave action. Although long periods of extremely inclement weather handicapped construction work, the cost of impounding water on the 32 projects was low.

This type of development is valuable from both the national and the local point of view. As a conservation measure it is of national moment, primarily because at small cost an appreciable part of what was once the country's finest waterfowl-breeding area is being restored to a condition comparable with its once natural, prolific, waterfowl-breeding capacity, so much so that many thousands of migratory birds nested on the easement areas during the year. Locally the necessary control of water and the creation of water bodies within the refuges did much to repair the havoc wrought by protracted drought, and the work incident to the development circulated approximately $200,000 in relief wages.

REFUGE RESTORATION AND DEVELOPMENT

Great strides in performing refuge restoration and development work have been made, particularly in architectural and hydraulic development, designing, and landscaping headquarters, residence, and service buildings, planning public recreational grounds, and directing activities of C. C. C. camps. The work of these camps has included cutting fire lanes through forests, improving roads, building observation towers and service buildings, erecting telephone lines between administration points, and constructing dikes and spillways to stabilize

water levels for the benefit of waterfowl and their food plants. Twenty-eight of these camps have been active during the year on 22 bird refuges and big-game preserves, and 5,600 young men have been at work restoring habitat for wildlife in general and providing for the ducks and geese a chain of natural habitats along the four principal waterfowl flyways—the Atlantic, the Mississippi, the Central, and the Pacific. Their work has been particularly outstanding on the Upper and Lower Souris Migratory Waterfowl Refuges, N. Dak., White River Migratory Waterfowl Refuge, Ark.; Malheur Migratory Waterfowl Refuge, Oreg.; Bear River Migratory Bird Refuge, Utah; Lake Mattamuskeet Migratory Waterfowl Refuge, N. C.; Savannah River Bird Refuge, Ga. and S. C.; and the St. Marks Migratory Bird Refuge, Fla. The diversity of improvements wrought by the C. C. C. men in these 28 camps, exclusive of improvement work done by the regular employees on other refuges, is shown in the following tabulation:

Structural improvements:		
Bridges:		
Foot	number	11
Vehicle	do	28
Buildings:		
Barns	do	4
Dwellings	do	12
Lookout towers	do	10
Service	do	72
Cribbing, including filling	cubic yards	26,775
Fences	rods	40,522
Guard rails	do	65
Power lines	miles	2.4
Sewage and waste-disposal systems:		
Disposal beds	square yards	8,625
Disposal tanks and pools	number	8
Sewer lines	feet	1,510
Telephone lines	miles	155.7
Water-supply systems:		
Open ditches	feet	505
Pipe or tile lines	do	20,911
Springs, water holes, small reservoirs	number	19
Storage facilities	gallons	22,500
Wells, including pumps and pumphouses	number	4
Other	man-days	408
Other improvements:		
Cattle guards	number	8
Signs, markers, and monuments	do	598
Stone walls	rods	251
Water conservation and flood control:		
Clearing and cleaning:		
Channels	square yards	563,916
Lake, pond, and reservoir sites	acres	2,677
Concrete lining of waterways	square yards	7
Dams, impoundment and diversion	number	27
Concrete	cubic yards	932
Fills, earth	do	84,851
Fills, rock	do	456
Excavations, earth	do	76,464
Excavations, rock	do	2,845
Masonry	do	1,258
Riprap	square yards	12,276
Steel	pounds	6,930
Levees, dikes, and jetties	cubic yards	326,522
Excavation of channels, canals, ditches:		
Earth	do	168,310
Rock	do	73
Lake and pond development	man-days	24,106
Pipe lines and conduits	feet	3,147
Riprap or paving:		
Rock or concrete	square yards	25,791
Brush or willows	do	6,856
Water-control structures other than dams	number	129
Concrete or masonry	cubic yards	1,885.8
Wood	feet	53,918
Wildlife habitat development:		
Experimental plots	number	3
Field planting or seeding (trees)	acres	465
Fish-rearing ponds	number	61
Food and cover planting and seeding	acres	5,684.2
Nurseries	man-days	3,095
Range revegetation	acres	92
Seed collection:		
Conifers (cones)	bushels	59
Hardwood trees	pounds	2,680
Seeds, tubers, and rootstalks (water-fowl food-producing plants)	do	61,984
Sodding	acres	94.6
Other work	man-days	17,199
Trees and shrubs moved and planted	number	1,833,286

Transportation improvements:		
Roads:		
Truck trails	miles	250.5
Quarrying limestone	tons	22,690
Crushing	do	14,217
Hauling	do	16,401
Foot trails	miles	13.9
Horse trails	do	4.8
Erosion control:		
Stream and lake bank protection	square yards	80,344
Area treated	acres	1,771
Treatment of gullies:		
Check dams, permanent	number	283
Bank sloping	square yards	450
Terracing	miles	14
Sheet-erosion planting	acres	752
Miscellaneous erosion-control work	man-days	4,279
Fire suppression and fire hazard reduction:		
Fighting forest fires	do	1,426
Firebreaks	miles	56.8
Fire-hazard reduction:		
Roadside	do	7.6
Trailside	do	1.0
Other	acres	1,868.5
Fire prevention	man-days	3,033
Recreational and demonstration area development:		
Beach improvement	acres	29.8
Fine grading, road slopes, etc	square yards	186,247
General clean-up	acres	6,543
Landscaping, undifferentiated	do	97.6
Obliteration:		
Roads	miles	2
Borrow pits, dumps	man-days	30
Parking areas and parking overlooks	square yards	19,486
Public campground development	acres	1.4
Undesirable structures razed	number	323
Soil preparation	acres	42
Walks, concrete, gravel, cinder, etc	feet	921
Other activities:		
Emergency work:		
Search or rescue	man-days	34
Wildlife feeding	do	580
Other work (floods, etc.)	do	3,173
Eradication of poisonous or pest plants	acres	998
Insect pest control	do	580
Maps	man-days	268
Marking boundaries	miles	787.7
Preparation and transportation of materials	man-days	29,007
Reconnaissance and investigation	do	1,004
Restoration of historic structure	number	1
Rodent control	acres	29,815
Surveys:		
Grade lines	miles	127
Lineal	do	245.5
Topographic	acres	55,982
Other work	man-days	990

Since few natural waterfowl habitats of large size are left, it has become most urgent that restoration be undertaken on areas formerly used but ruined for waterfowl by unsuccessful drainage or otherwise. On almost every area on which work was done it was necessary to impound water to insure a safe and permanent supply, and to accomplish this has meant the maintenance of an adequate force of trained hydraulic engineers and engineering aides.

Architectural work on bird refuges and at other field stations of the Bureau has included the designing of special dwelling and service buildings to meet climatic conditions in the South, and the redesigning of many features of the standard buildings for other sections on the basis of improvements found necessary after 1 year's use. Complete landscape plans were drawn up for each refuge headquarters and for the most part operations were instituted during the growing season, native trees and shrubs being used for the initial plantings. Landscaping has been conducted on the theory that local material should be used, and the demonstration will thus have a valuable educational aspect. Besides having landscape appeal, the work will be of practical service to wildlife in providing food and cover for insectivorous and upland game birds. Recreation grounds, bathing beaches, and other facilities for the public are planned for some of the principal refuges. Such facilities at the Upper and Lower Souris (N. Dak.), Sand Lake (S. Dak.), and Seney (Mich.) Migratory Bird Refuges are outstanding demonstrations of how the public can be thus served without sacrificing the wildlife values of the refuges.

Hydraulic reconnaissance and general planning of water impoundment and stabilization structures were made possible through the cooperation of the

Bureau of Agricultural Engineering. Water-resource work was completed on all refuges acquired during the previous year, including such important structural features as a 112,000-foot storage dam on the Upper Souris (N. Dak.) Refuge, a complicated diversion dam and canal on the Medicine Lake (Mont.) Refuge, a system of diking on the Lacreek (S. Dak.) and the Lower Souris (N. Dak.) Refuges, and numerous smaller impoundment structures on other refuges. Technicians of the Bureau of Agricultural Engineering made numerous hydraulic reconnaissance studies for developing new waterfowl refuges and perfecting the water supply on many that are older. Especially important and interesting large-scale studies were made on the Bear River reservoir in Utah and the Freeze Out, Priest, and Benton Lakes project in Montana.

Water-utilization studies looking to the development of the best type of ponds for nesting marshes, consistent with available water supplies, also a feature of cooperative work with the Bureau of Agricultural Engineering, were made on the Malheur Migratory Waterfowl Refuge in Oregon, the Bosque del Apache area in New Mexico, and the Delta Migratory Waterfowl Refuge in Louisiana. Particular attention was given to the impoundment of freshwater ponds on Atlantic coast refuges, where the ecology is mostly that of the salt marsh and where fresh water is naturally limited. It is remarkable how a few acres of fresh water on these salt-marsh refuges increase their usefulness to wildlife.

Because many of the great nesting refuges on the Great Plains and in the western mountain region are dependent for an adequate water supply on the run-off of local streams and rivers, steps have been taken to make the necessary water filings, and during the year preliminary filings were made, and so far as was possible proved up, on 11 important refuges in 6 States.

PROVIDING FOR MAINTENANCE AND PATROL

All bird refuges ready for administration have been suitably staffed with associate, assistant, or junior refuge managers, according to their size and importance in the refuge system. Organization of the work has been by natural regions on a geographical basis and according to the three types of refuges into which the areas naturally fall. The best technically trained man available, generally an associate manager, was placed on the most important refuge of a region, of which there were 14, and from this as a center he has applied his administrative and biological training on the lesser refuges within fair travel distance. Thus it has been possible to function with a minimum number of highly trained and high-salaried men.

In addition to rounding out a new refuge and making it function for wildlife in full measure, after the major engineering and architectural work has been done, maintenance has included work on thousands of yards of riprapping, small levee and dyke impoundment, miles of fire- and truck-trail development, patrol-tower erection, food and cover plantings, range recovery, reforestation, erosion control, and such public relations as enforcement of bird-protection laws and protection from vandalism. Major equipment purchased for the new refuges, costing about $150,000, has included trucks, transportation vehicles, tractors, farming equipment necessary to produce supplemental food on the refuges, materials for fencing, patrol and work boats, boundary and warning markers, planting stock, seeds, fire-suppression apparatus, and quarrying and road-construction tools and machinery.

New types of warning and refuge boundary shields were designed, with final standardizing on one of heavy-gage enamel with a 10-year guaranty. Extensive and detailed inventories of wildlife have been made on the refuges, and to increase the nesting output of the northern nesting refuges considerable attention has been given to the suppression of predators, including coyotes, skunks, crows, and snapping turtles. The greatest mortality is during the incubating stage, and in this period about 60 percent of the eggs are destroyed; but there is relatively little mortality after a successful hatching.

In disposing of excess refuge byproducts during the year, the letting of haying and grazing leases netted $18,393.14, without lessening refuge values to wildlife. During the severe drought in the latter part of the year, the human need for relief and assistance was so great that water supplies were made available to the public, and forage, including 3,161 tons of hay, was taken from certain refuges. Where timber reservations remained on land acquired for refuge purposes, protective cruising and reserving saved many trees that produce foods

valuable to wildlife, notably on the 110,000-acre White River Refuge, Ark., which was entirely covered from this standpoint alone.

During the exceptionally severe winter of 1935–36, the demand for prolonged emergency feeding of wildfowl and upland game birds were met, not only on refuge areas but also at important neighboring concentration points. Tons of grain received from Federal grain-inspection offices had been previously stored at convenient points in anticipation of such an emergency.

ERECTION OF CURRITUCK SAND FENCE

Currituck Sound, in Currituck County, N. C., has long been known for its winter-season concentrations of waterfowl, especially geese. Its value for this purpose, however, was seriously jeopardized by a severe storm in 1932, during which the ocean broke through the beach, the resulting influx of salt water gradually transforming the fresh water of the sound to brackish and threatening the existence of its fresh-water food plants. Appreciating the gravity of the situation, Congress, by the Agricultural Appropriation Act approved on May 17, 1935, made $10,000 available to the Bureau of Biological Survey for materials to repair the break in the beach, including the construction of a sand fence to exclude ocean waters from the sound.

The State Department of Conservation and Development of North Carolina, with W. P. A. labor and under supervision of the Bureau, began construction of a sand fence and dike in January. A dragline was used to fill in with sand between double rows of piling, and four rows of brush were anchored on top. Wind action on the beach sand immediately started the gradual raising of the elevation of the fence and the widening of its base, and it now appears certain that the break, which before the construction work began, was virtually a canal from ocean to sound, will become a wide and sea-resisting barrier similar to the remainder of the beach.

ADMINISTRATION OF WILDLIFE REFUGES

At the beginning of the fiscal year there were 99 bird refuges under administration by the Biological Survey, besides 7 big-game preserves on which birds also are protected, a total of 106. The area of the 90 refuges within the United States proper was 2,050,570 acres: 57 refuges, aggregating 1,886,766 acres, are primarily suited to waterfowl; and the remainder, including various bird rocks, rookeries, and nesting islands along the seacoasts and about interior lakes, are principally the resorts of sea birds and other nongame species.

The number of refuges was increased during the year by the establishment of 55 waterfowl refuges and 3 big-game ranges, the latter on the public domain in conjunction with the organization of grazing districts under the Taylor Act of 1934, totaling 3,020,671 acres. These areas, including additions to several refuges established in other years, aggregated 3,285,923 acres. At the end of the year the refuges under the Bureau's administration numbered 164, with acreage as follows: Waterfowl refuges in the United States, 112, aggregating 2,146,705 acres; other bird refuges, 42, with 27 in the United States aggregating 31,249 acres; and 10 big game preserves, the area of the 9 in the United States being 3,158,539 acres. The area of the 148 refuges in the United States aggregated 5,336,493 acres. In addition the acreage of 12 in Alaska is estimated at 4,603,410, and of 2 in Puerto Rico at 3,120 acres. The big-game preserve in Alaska is the Nunivak Island Wildlife Refuge of 1,111,000 acres, established in 1929 and now used chiefly for reindeer-caribou cross-breeding experiments and for the reestablishment of the musk ox in the Territory (mentioned on p. 7). This makes an estimated total of 9,943,023 acres of wildlife refuges administered by the Bureau, exclusive of its two refuges in the Hawaiian Archipelago, one of which has an extent of more than 1,000 miles, with acreage undetermined.

At the end of the year 50 additional refuges were in process of establishment, but not yet placed under administration by the Survey, making a total of 214 wildlife refuges now under administration or in process of establishment. A revised list, entitled "Bird Refuges and Big Game Preserves Administered by the Bureau of Biological Survey", was issued in April (leaflet BS–16).

BIRD REFUGES

It is impracticable to report here on all the bird refuges administered by the Bureau, but notes on conditions and accomplishments on a few will indicate the nature of their development and administration for wildlife protection.

WHITE RIVER MIGRATORY WATERFOWL REFUGE

The 110,000-acre White River Migratory Waterfowl Refuge, Ark., which was given inviolate sanctuary status by Executive order of September 4, 1935, by reason of its great concentrations of ducks and its remoteness from any other waterfowl sanctuary, is a major refuge in the system. It is at the point of greatest waterfowl concentration in the Mississippi Valley flight lane, both spring and fall, as most of the ducks going to and from their breeding grounds over a region stretching from eastern Montana to western Ohio, gravitate to the main valley of the Mississippi River, and all of these flights converge in the "bottle neck" in which the refuge is situated.

Under the supervision of Biological Survey technicians and engineers, two 200-man C. C. C. camps have been at work on the refuge since the first week of July 1935. To meet the needs of the tremendous number of birds that congregate there and thus to prevent depredations in adjacent rice fields, the men have introduced and cultivated large areas of food plants. Both camps have gathered seed stock for planting and cleared certain areas so as to favor pin oaks and other waterfowl food-producing plants. Large quantities of desirable seeds and root stocks also were made available for use at White River by camps advantageously situated for making such collections on other refuges.

Another activity essential to the development program, including the success of the food plantings, was the construction of dams and dikes to create pools and lakes with stable water levels and to protect existing lakes. During flood periods some of the best lakes had filled with silt and become useless for waterfowl. Not only was loss of these lakes a serious threat to the effectiveness of the refuge, but silt deposits prevented the growth of herbaceous plants, greatly varying water levels destroyed them, and strong currents over much of the refuge washed them out. The dikes and dams constructed will protect from flood waters the food plants in a large number of valuable feeding areas. Silting has now been reduced to a minimum by the construction of small dams and the clearing away of willow sprouts.

With much of the refuge area under water throughout the year, the problem of transportation had to be solved, for upon this depends all construction operations as well as investigation, feeding, and law-enforcement activities. The C. C. C. camps constructed 37 miles of truck trails and 8 miles of foot trails and built 8 bridges. Trees were cut in the deep-water areas to open avenues for transportation by boat, and in the aggregate 20 miles of clogged low-water channels were cleared of logs and debris. Within a short time all parts of the refuge will be accessible either by truck or by boat.

Boathouses, patrol boats, and boat landings were constructed, 32 miles of telephone lines were put in operation, and at the close of the year three observation towers were being erected.

TULE LAKE, CLEAR LAKE, AND UPPER KLAMATH LAKE BIRD REFUGES

The major part of the development work at Tule Lake and Clear Lake Bird Refuges, Calif., and Upper Klamath Lake Bird Refuge, Oreg., which are close together, has been conducted from Clear Lake. A C. C. C. camp, composed first of World War veterans and later of junior enrollees, maintained there since October 1935, has built 34 miles of graded gravel roads, 4 cattle guards, and a bridge to make the key areas on the three refuges accessible to patrol and development work. In addition it has constructed 250 nesting rafts, many of which were used by the birds this year, and will establish 14 nesting islands in the Tule Lake sump area. Pipes have been installed to carry a water supply to a nursery where more than 15,000 willows and other trees, which later will be transplanted to the nesting islands, are being grown. To facilitate patrol activities five 20-foot wooden observation towers have been erected near the sump.

Removal of debris from the channel at the mouth of Lost River facilitates patrol by boat and permits free passage of water into the Tule Lake sump, thus eliminating danger to the dikes from high water. Lowering the water level exposed a highly desirable tract, which has been fenced and planted with suitable cover and food-bearing plants. Work was progressing also at the close of the year on the Tule Lake headquarters site by the removal of old buildings and blasting away of boulders. A supplemental camp, established late in the year at the Klamath Refuge, has built a concrete water-storage tank, installed plumbing for a gravity water system, and completed clean-up work preliminary to erecting headquarters buildings.

At Clear Lake a telephone line and a truck trail about 7½ miles long are being constructed, and a 925-acre tract, the complete use of which had been granted by the Reclamation Service, has been surveyed and marked for fencing. This area will later be used for food and cover planting in an effort to meet the needs of the great numbers of geese and ducks that concentrate there. The C. C. C. enrollees have built a speed boat, a work boat, and a boat of the sea-sled type, and have begun the construction of a barge to be used in connection with fencing, posting, and other activities on the Klamath Refuge.

At Tule Lake records kept at the public shooting grounds point unmistakably to the fact that the 30 consecutive days of hunting permitted under the 1935 regulations were much less destructive to the birds than the staggered season previously in effect. Although it was estimated that there were twice as many birds on the refuge as in 1934, in 1935 only 273 geese and 914 ducks, or 3.45 birds per man, were taken, as contrasted with more than double the number per hunter in 1934, when 709 geese and 2,263 ducks were taken, an average of 6.96 per man.

At least 86,000 ducks of all species, and 4,000 Canada geese nested in these refuges during the season, and at the height of the fall migration there were about 150,000 geese and 205,000 ducks upon them. A survey at Tule Lake in January indicated that approximately 2,000 mallards, 1,100 baldpates, 2,000 shovelers, 3,000 pintails, 200 canvasbacks, 400 lesser scaups, 500 ruddy ducks, 400 lesser snow geese, 600 white-fronted geese, and 2,500 Canada geese were on that refuge.

Patrol activities on the refuges were concentrated in the public shooting areas and resulted in the apprehension of 37 violators. The California Division of Fish and Game assisted materially by furnishing five patrolmen. Damage to dikes and ditch banks by burrows made it necessary to trap muskrats, of which 957 were taken. To curb the predator population, 305 coyotes and lesser numbers of bobcats, great horned owls, skunks, weasel, minks, and feral cats were destroyed. In a very short period during which bird-banding activities were conducted, 700 pelicans, 200 Caspian terns, 1 goose, 50 gulls, and 105 ducks were banded.

For planting suitable food and cover plants on the new islands, the C. C. C. camp collected and stored more than 50,000 pounds of propagating material. Extensive grazing on the refuge areas makes it essential that every possible acre that can be fenced and protected be utilized for the propagation of nesting-cover and food-producing plants.

ST. MARKS MIGRATORY BIRD REFUGE

The St. Marks Migratory Bird Refuge, Fla., is being enlarged by the acquisition of 17,975 acres, approximately 2,500 acres of which will be used in the construction of fresh-water ponds and the remainder as a marsh feeding ground for waterfowl. With this additional area, the refuge will have the best feeding range for waterfowl on the Gulf coast of Florida. Activities during the year were designed primarily to give ample food and protection to the wintering wildlife, particularly the great numbers of ducks and geese. A development program, through a C. C. C. camp established late in April, contemplates, in addition to the creation of several large fresh-water ponds, the construction of a new headquarters building, fencing to eliminate unauthorized grazing and to prevent damage to dams and dikes by wild hogs, construction of approximately 20 miles of truck and patrol trails, erection of a new 100-foot steel watch tower to replace existing towers nearer the coast and serve for both game and fire patrol, and other improvements for the benefit of the birds and for facilitating administration.

The Canada goose continued to be the most prominent of the migrant birds on the refuge, and it was estimated that approximately 9,000 were there during the winter. The increase over the numbers of a year ago is probably attributable to the abundant food growths in the shallow tidal waters and to the fact that there was sufficient rainfall to maintain a supply of fresh water. Ducks, though in about the same numbers as last year, arrived considerably later than usual, probably the result of improved feeding conditions in the interior. There was an estimated 30-percent decrease in the numbers of scaups, and a slight decrease in the number of black ducks, but some increase in the numbers of mallards, goldeneyes, and pintails, and a considerable increase in the ringnecks. The shore birds showed little change in numbers though sandpipers and the greater yellowlegs were not so numerous as heretofore. Hundreds of

gulls and terns remained on the refuge all winter and began migrating about April 1. Quail and turkeys have increased substantially. Surveys indicate that minks and raccoons also are increasing. The population of deer and otters appears to be unchanged, and skunks continue to be the most numerous mammal on the refuge.

DEER FLAT BIRD REFUGE

A thorough survey was made on the Deer Flat Bird Refuge, Idaho, and plans were drafted for its revegetation and for constructing nesting islands and a recreational area. The refuge was much used by birds during the migrating and hunting seasons only, but with the introduction of the improvements now contemplated and the restoration of cover, which will follow the elimination of grazing, it is hoped to establish a well-populated breeding area. No losses of birds either by disease or freezing were noted. About 30,000 crows were destroyed on the refuge in December, and during the winter approximately 35 tons of carp were seined out by private individuals.

DELTA MIGRATORY WATERFOWL REFUGE

The Delta Migratory Waterfowl Refuge, La., covering 39,208 acres, was established by Executive order of November 19, 1935, and is considered an outstanding waterfowl wintering area. The development program involved a general clean-up, repair of buildings, surveying activities, and appraisal of aquatic waterfowl foods. Two old outboard hulls, an unused houseboat, and a small launch abandoned on the shore were reconditioned; the two outboards, fitted with motors, and the launch have been in daily use as patrol boats, and the houseboat was of service in transporting work crews and materials during fencing operations. On the part of the refuge transferred from the United States Public Health Service, old broken boardwalks were taken apart and stacked, and hundreds of things were removed and destroyed to guard against fire and depredations. All wharves were cleaned, repaired, and strengthened.

Shipments of creosoted posts for fences and boundary markers arrived late in the year and with the help of a barge loaned by the Army Engineers were transported to a point on the refuge from which they could best be distributed. Trails were chained and cut, and marker posts placed. Stenciled wooden markers were made from materials at hand and put in place. Before the work of posting was completed, people hunting in the neighborhood were notified of the refuge boundaries, boats were checked for the kill, and hunters' licenses were examined. Through the cooperation of local citizens there were practically no enforcement difficulties on the refuge.

Blue, white-fronted, and snow geese, ducks, white pelicans, herons, ibises, shore birds of many varieties, gulls, and terns used the refuge during the year. Clapper rails nested there in large numbers, together with snowy egrets, gulls, and terns, and the brown pelican is a year-round resident. Approximately 151,000 ducks and geese were observed in January, though it was estimated that this survey covered only about 25 percent of the actual bird population. The refuge probably cared for three-fourths of a million birds, half a million being geese and ducks. To the abundant growth of widgeon grass, bulrushes, and banana water lilies were added sowings of sago pondweed and wild millet, and a banding station was constructed and put into operation.

BLACKWATER MIGRATORY-BIRD REFUGE

About 200 acres of the Blackwater Migratory-Bird Refuge, Md., were under cultivation during the year, part being planted to grains for storage and part to patches of wild millet, smartweed, and other waterfowl food plants. A corn crop of about 1,000 bushels was planted, raised, and harvested by the C. C. C. camp. Small quantities of seed of wild salt-water bulrush, water hemp, and wild millet, all plants suitable for duck food, were collected.

Feeding of waterfowl, begun on October 28, continued to the last of December, when a freeze occurred and all the ducks left for southern waters. Regular patrols were maintained from late fall throughout the winter, both for the protection of the waterfowl and to guard against fire. No fires and no violations were observed on the refuge during the year. Weekly counts of the waterfowl were made from three points, and the data were supplemented by observations made on patrol trips on other days and correlated with weather conditions.

The records thus obtained show that the waterfowl arrived a week or 10 days earlier than in the previous year, that there was an increase in numbers of about 10 percent, and a general tendency of the waterfowl to remain late in the spring and to delay their migration. A study of nesting conditions of black ducks and blue-winged teal was also carried on.

Records were maintained of the numbers of muskrats trapped and a census made of the muskrat houses. A small number of crows found doing excessive damage to nesting ducks were eliminated.

LAKE BOWDOIN MIGRATORY-WATERFOWL REFUGE

The Lake Bowdoin Migratory-Waterfowl Refuge, Mont., an area of 16,040 acres, received inviolate sanctuary status by Executive order of February 14, 1936. During the year 21 miles of boundary fence were erected, posting operations were completed, and a site was selected for a headquarters building. Small food patches were planted for the nesting birds, although their numbers were below normal because of the low water of the lake and scarcity of cover from overgrazing. All cattle were removed from the refuge, and it is planned to have no grazing there during the next season. In the fall of 1935 a group of antelope appeared on the refuge and were fed during the severe winter weather.

RED ROCK MIGRATORY-WATERFOWL REFUGE

To nature lovers the 27,328-acre Red Rock Migratory-Waterfowl Refuge, Mont., which was given sanctuary status by Executive order of September 4, 1935, is outstanding because it harbors almost all of the few trumpeter swans remaining in the United States. Actual observations indicate that at least 16 of these birds were raised on the refuge during the year, and 44 were counted there during the winter. In the brief time the refuge has been under the administration of the Biological Survey more than 200 species of birds have been observed. Numbers of ducks, mainly pintails, cinnamon teals, green-winged teals, mallards, lesser scaups, and canvasbacks nested about the lakes, and during the fall it was estimated that as many as 200,000 ducks were using the water and marsh areas. Hundreds of sandhill cranes migrated through the section, and 25 pairs nested about the lakes. Long-billed curlews also nested on the refuge last year, and great numbers of sage hens, Columbian sharp-tailed grouse, and ruffed grouse inhabited much of the upland. With the removal of cattle from the nesting grounds the refuge will again be one of the most productive wildlife areas in the West, both of waterfowl and of upland game birds

To encourage the swans, 24 artificial nesting islands were constructed and anchored in place, and during the extremely inclement winter more than 4,000 pounds of grain were fed to the swans that wintered in the heads of the various springs east of the upper Red Rock Lakes, where the heavy ice formation had almost completely shut off the food supply. The birds were thus brought through the winter without loss.

With the exception of buildings to be converted into patrol cabins and service stations, all old sheds, corrals, and other structures are being removed so as to restore the area to its natural condition. During the fiscal year 81 such buildings were razed, bridges and fences were reconditioned, and all the salvageable material was stored for future use. Trees, shrubs, and aquatic plants (including sago pondweed, wapato, wild millet, and prairie bulrush) were introduced to improve the habitat for wildlife. With the removal of hundreds of head of livestock from the lower refuge lands where the ducks, swans, and other birds most frequently nest, the vegetation is making rapid growth, and food and nesting-cover conditions are improving.

CRESCENT LAKE MIGRATORY BIRD REFUGE

Early in April, at the peak of the waterfowl migration through the Crescent Lake Migratory Bird Refuge, Nebr., estimates indicated that there were approximately 55,000 ducks on the refuge, an 80-percent increase over the numbers for the corresponding period last year. Rather than indicating a proportionate increase in waterfowl generally, however, this increase was probably due to the fact that the birds, hard pressed by drought and other unfavorable conditions, were compelled to concentrate in one of the few places that remained suitable to them. Early in the summer it was estimated that approximately 3,000 coots, 1,750 blue-winged teal, 1,450 shovelers, 600 mallards, 350 ruddy ducks, 300 pin-

tails, 200 redheads, 150 gadwalls, 100 canvasbacks, 50 baldpates, 25 scaups, and 25 green-winged teal were nesting on the refuge. Despite the unusually severe winter, ring-necked pheasants appear to be on the increase and are to be found over the entire 41,000-acre refuge. About 80 of these birds spent the winter near the headquarters buildings and were fed during the severe weather.

On the Crane Lake unit a new nesting area was developed and wild rice was planted in a large section along the west shore. Forty acres of food patches were cultivated and planted with squaw corn and soybeans to provide a much-needed winter supply for both waterfowl and upland game. With the removal of grazing, native vegetation will flourish in the entire area. Other physical developments include the fencing of a 3,700-acre area where grazing had heretofore been permitted, construction of a telephone line between the ranch headquarters and the Island Lake recreational area for law-enforcement and fire-prevention purposes, relaying of water pipes to prevent freezing in severe winters, and removal and salvaging of materials from old ranch buildings. The refuge will be enlarged by the addition of 4,150 acres of highly desirable feeding and nesting grounds, title to which, however, has not yet been vested in the United States. Refuge employees have continued to cooperate with the United States Weather Bureau by keeping meteorological records.

VALENTINE MIGRATORY WATERFOWL REFUGE

Eleven of the famous Valentine lakes and the crooked silver streak of water that is the Gordon Creek-Hackberry Lake diversion ditch are now visible, on a clear day, from the observation tower of the Valentine Lakes Migratory Waterfowl Refuge, Nebr. During the year title to most of this 68,910-acre refuge was vested in the United States, and development, construction, and investigational work, performed in the main by C. C. C. camp labor, progressed satisfactorily. In September a crew of C. C. C. enrollees began to collect all available seeds and tubers of duck-food plants. The Valentine Lakes are fortunate in having a rich crop of sago pondweed seed, and at the time the lakes froze over, in November, 1,900 pounds had been collected and stored. As this was greater than the quantity collected on any other refuge, it was possible to ship generous supplies for replanting on refuges elsewhere in Nebraska and in North Carolina, Georgia, Louisiana, Oklahoma, North Dakota, and Montana. Large supplies of bulrush, juniper, and sumac seeds also were collected.

Six acres of nurseries were prepared to care for approximately 700,000 ash, elm, jack pine, mulberry, and hackberry seedlings that had been made available to the Biological Survey by the shelterbelt division of the Forest Service. These seedlings have been lined out in nurseries for planting throughout the refuge next spring. Two hundred thousand additional tree and shrub seedlings were purchased, including jack pine, caragana, mulberry, Russian-olive, buckthorn, wild plum, ash, and elm, which were planted on 25 plots to provide proper ecological environment for various species of wildlife. One acre of nursery beds was planted with Russian olive, hawthorn, haw, mulberry, juniper, and sumac seeds. Areas on two lakes have been planted to wild rice, and the mucky shores of three others with wild millet. Approximately 6 acres of lake bottom were planted to sago pondweed seed to increase the already prolific growth of this plant. To further augment the waterfowl food supply and to provide also for the needs of upland game, 28 food patches were sown on favorable areas. The principal plantings were corn and soybeans with secondary sowings of proso millet, barley, and rice.

Four islands were constructed at Pelican Lake during January, where the surface was frozen over, by ice blocks being cut out and earth dumped through the openings. Pelicans have already taken over one of these islands as a resting place and ducks are using the others.

To provide a permanent and stable water supply for the refuge, five dikes have been constructed on the Sweetwater Valley unit, and a diversion ditch was constructed between Hackberry and Dewey Lakes, so that the latter may receive all excess waters from Gordon Creek. On the basis of a survey to determine the various lake elevations plans are being made for additional impoundment and control devices. At the headquarters site a residence, administration building, service building, garage, barn, tuber storage cellar, pump house, and boathouse are being constructed, principally with C. C. C. labor.

Approximately 28,000 fence posts of Black Hills pine—about one-third of the number required for the refuge boundary fence—were peeled and ricked for

seasoning and given a two-bath creosote treatment in two vats constructed for the purpose.

To aid the formation of a sound management program, research was undertaken to determine the extent of waterfowl nesting, deficiencies in nesting cover, and practicable predator control measures. As coyotes presented the most serious predatory menace to both waterfowl and upland game birds, 51 of these animals have been taken since October. It was also found necessary to remove about 60 nesting crows, a few horned owls and snapping turtles, and 75 jack rabbits. Experiments were made in storing sago pondweed seeds, and experimental work with jack-pine planting was a conspicuous success in that a 95-percent growth was obtained from what normally, in the sand hills, is a difficult transplanting operation. Because of the drought little water entered Hackberry Lake this year, and it was impossible to determine the effectiveness of a fish screen, installed as an experiment, in excluding carp and carp fry.

During the unusually severe winter, grain-feeding stations were maintained for pheasants and grouse, and during the cold weather and heavy snow in March for several thousands of ducks. Pintails, mallards, redheads, gadwalls, baldpates, teal, and shovelers, which were noted in large numbers at the stations, are representative of the species that breed on this refuge and, during migration, find sanctuary there.

LAKE MATTAMUSKEET MIGRATORY WATERFOWL REFUGE

Accomplishments at the Lake Mattamuskeet Migratory Waterfowl Refuge, N. C., included the construction of a modern administration building by remodeling the old pumping plant, the removal and sale of old machinery, boilers, pumps, and other equipment, and the beginning of conversion of an old chimney into an observation tower. Six dwellings were renovated for use by officials and others connected with the work; three garages were constructed; the old post-office building was made into a temporary storehouse for incoming grain; and nine buildings were razed and the material salvaged for use in further development. Near the eastern end of the refuge a two-room cabin, erected for the use of patrolmen and as a headquarters building for that section, has been of service in connection with efforts to reduce the number of violations there. Telephone lines, power lines, and sewers were connected with the office and dwellings. One 40-foot barge and one 18-foot barge were built for use in dragline operations and in hauling heavy materials through the canals.

The control of water depth in the lake was insured by the installation of two flood gates, one hand-operated and the other partly automatic, and other facilities for water control are planned. A 38-mile combination fire lane and boundary trail was cut, varying in width from a few feet to 20 feet. Fourteen thousand fence posts were cut and 440 metal marker posts, most of them with concrete bases, were made preparatory to starting fencing operations. Temporary bars were placed across roadways and entrances, and the principal refuge roads were widened, leveled, and scraped to permit use by heavy trucks in development operations as well as by passenger vehicles. Forty-five acres of farming land were made available by the erection of a new dike. To conform to the general landscaping plans as well as to increase the outflow of water, two canals were widened. The ground around the administration building was leveled, adjacent watercourses were filled in, and pine trees planted around the residences.

A good deal of experimental food planting was begun, the object being mainly to give the waterfowl enough food to enable them to remain inside the refuge instead of resorting to adjoining farm lands. It was also desired to encourage upland game birds by improving food and cover conditions on the refuge. A 90-acre tract was planted to rice, corn, and soybeans. Duck foods were planted in sheltered spots in the lake, and the canal banks were sown with food plants for ducks, geese, and upland birds. About 150 acres of the refuge were planted with sumac, pokeberry, elderberry, grape, lespedeza, wapato, sago pondweed, chufa, rice, smartweed, yellow soybeans, millet, late buckwheat, Lorita variety of soybeans, and bulrush to provide food and cover.

During severe winter weather approximately 100,000 pounds of mixed grain were scattered inside the refuge for the benefit of thousands of starving ducks, Canada geese, and swans. This feeding probably saved many birds from death, since the number found dead was noticeably less than during the preceding year.

Twenty-nine nesting boxes for wood ducks were placed on the five or six heavily wooded islands in the western part of the lake. Three traps were put in operation this year and approximately 560 ducks (pintails, blacks, mallards,

widgeons, and green-winged teal) and 8 Canada geese were caught and banded. Data on wintering, nesting, and migrating birds were taken, and several species have been added to the previous lists. There are now records of 168 forms of bird life, including swans, geese, ducks, loons, grebes, cormorants, egrets, herons, terns, bitterns, hawks of several species, eagles, ospreys, sandpipers, gulls, quail, doves, owls, and a large number of perching birds.

About the same number of Canada geese used the refuge as last year and possibly a greater number of ducks. Mallards, black ducks, and wood ducks as well as many species of perching birds have been found nesting on or in the vicinity of the refuge.

The North Carolina State Department of Conservation, under supervision of the Bureau of Biological Survey, set aside approximately 10,000 acres of land and water adjacent to the lake for the hunting of waterfowl from regulated blinds and with regular guides. Approximately 648 hunting permits were issued and reported on weekly during that time. Ducks taken included mallards, black, gadwalls, baldpates, pintails, green-winged teal, shovelers, and scaups. Fishing is allowed on the refuge throughout the year, and as many as 50 permits a day were issued.

Cattle, which had been on the refuge for some time, were removed, and the cooperation of adjacent landowners was obtained in regard to strays. It was noted that deer, foxes, raccoons, minks, and wildcats are present to some extent, and that muskrats are especially abundant. The strict patrolling of the lake and the surrounding territory last winter brought about a marked reduction in the number of violations and very little of the wildlife was destroyed. Those engaged in patrol did much good work by mixing with local hunters and impressing them with the fact of the growing scarcity of wildlife and the need of conserving it. Eleven violators were arrested.

Daily thermometer and water-gage readings were made and incorporated in a monthly report to the office of the Weather Bureau at Raleigh, N. C.

ARROWWOOD MIGRATORY WATERFOWL REFUGE

Three good-sized lakes (Arrowwood, Jim, and Mud) cover a large part of the 16,876-acre Arrowwood Migratory Waterfowl Refuge, N. Dak., which was given inviolate sanctuary status by Executive order of September 4, 1935. Situated in a region that at one time produced innumerable waterfowl, the refuge now offers nesting and resting attractions to large concentrations of ducks, mostly canvasbacks, redheads, mallards, and pintails, and to lesser numbers of Canada geese, swans, and white pelicans. Structural and biological improvements during the year are making it more serviceable to waterfowl and are facilitating efficient administration.

Construction work under contracts, let after competitive bidding, consisted of the building of dikes and dams with control gates and spillways to impound water of the James River, which passes through the water units of the refuge, and to allow seasonal distribution of the water supply to create favorable conditions for aquatic plant production and for the growth of nesting cover. Substantial administration buildings consisting of headquarters residence, service building, barn, boathouse, and pump house, all of fireproof materials, also were constructed under contract.

The work of the C. C. C. camp, which has been on the refuge since August 1935, has included development of a public recreational area on Arrowwood Lake, construction of truck trails, fences, and telephone lines, and erosion control, lake and stream bank protection, fire-hazard reduction, wildlife food and cover planting, and nursery stocking. Two major earth-fill, riprap, and rubble-masonry type dams were constructed, and water-control devices installed in each to raise and stabilize water levels, and two secondary dams of earth and riprap construction were built in coulees to impound water to a depth of approximately 5 feet and thus substantially increase the nesting areas.

Debris and unsightly growths were removed to permit speedy recovery of suitable waterfowl habitat. Many of the farm buildings that could not be used for refuge purposes were razed; 80,000 feet of lumber were salvaged for constructing a six-section garage and storage building at the camp, a blacksmith shop, a workshop, and other storage buildings. Fifteen miles of patrol and service trails, protected from water erosion by the installation of five rock-paved spillways and six rock culverts, were constructed to provide necessary access to various key points of the refuge. One and one-half miles of 20-foot roadway were built up and surfaced with gravel, and a 110-foot wooden bridge was built

for public use. Telephone facilities were provided by the construction of a temporary line to the camp office buildings, and poles for the permanent line have been erected.

In the biological reconditioning of the refuge, an important camp activity, provision was made for the storage of all types of seeds and tubers for waterfowl food and cover. An aquatic cellar, with a concrete tank 40 feet long and 20 feet wide, divided into eight bins through which water may flow freely, was constructed to provide safe storage for aquatic-plant seeds and tubers, and a smaller dry cellar was excavated and walled with rock masonry. In these have been stored more than 2,400 pounds of seeds and tubers, principally wild millet, sago pondweed, wild rose, arrowhead, waterplantain, ash, hackberry, haw, snowberry, silverberry, and various species of bulrush. Shrub seeds gathered on the refuge were planted in an irrigated nursery together with more than 25,000 seedlings of green ash, caragana, and other species, which were obtained through the cooperation of the shelterbelt authorities. Forty thousand trees and shrubs, principally nursery stock, of hackberry, Russian olive, Chinese elm, honeysuckle, wild plum, and caragana, were planted in patches throughout the refuge. Ten thousand bulrushes were planted on the shores of Arrowwood Lake and, in addition, 10,000 square yards of its shore line were seeded with wild millet. Other aquatics, including sago pondweed, duck potato, waterplantain, smartweed, and burweed were planted in the low marsh areas, and to augment further the natural food supply 555 acres in various-sized plots were sown to barley, rye, and native food plants. Wild millet, willow, and bulrush were planted to prevent the erosion of the lake-shore dikes, borrow pits, and gullies; more than 20 acres of dike surface were sown with wild millet; all earthen dams were seeded to the tall sandgrass and wheatgrass, and 110,000 willow cuttings and seedlings were used in protective planting operations on areas adjacent to water-impoundment structures.

Sixty-four nesting islands built in the three lakes were used to a considerable extent by waterfowl. Five were made of large boulder-sized rocks so as to serve also for fish shelters.

Though conditions did not permit an entirely satisfactory survey of the waterfowl breeding population, it was estimated that there were within the refuge approximately 1,000 pairs of breeding waterfowl, principally ruddy ducks, shovelers, gadwalls, and scaups, with lesser numbers of blue-winged teal, canvasbacks, baldpates, and pintails. A few pairs of mallards, green-winged teal, and ringnecks were noted. Western grebes, eared grebes, and black terns nested in large numbers on Arrowwood Lake.

During the migration period as many as 10,000 birds, largely canvasbacks, scaups, and redheads, frequented Jim Lake and small flocks of Canada and white-fronted geese remained on the refuge for a short time. Large flocks of pintails, blue geese, and snow geese passed over in spring. Four species of upland game birds (ring-necked pheasants, sharp-tailed grouse, pinnated grouse, and Hungarian partridges) are found on the refuge in large numbers. During the unusually severe winter at least 60 percent of the pheasants on the refuge and in adjacent areas perished, but the other three species survived apparently without exceptional difficulty. Apparently the high mortality rate among pheasants was entirely due to freezing and the coating of their nostrils and eyes with ice. The birds were in good flesh and had full crops. Despite this heavy mortality there is no scarcity of pheasants, and it would seem that they must have been unusually abundant last fall.

The larger predatory animals are too few to create a control problem, but during the spring 362 crow nests were destroyed, and this activity will be continued. The great horned, long-eared, and short-eared owls, and the red-tailed, Swainson's, and marsh hawks were found beneficial in controlling pocket gophers, ground squirrels, and rabbits, so much so that their activities in this direction outweigh the destruction of an occasional game bird.

LOWER SOURIS MIGRATORY WATERFOWL REFUGE

The Souris (or Mouse) River, which flows through the Lower Souris Migratory Waterfowl Refuge, N. Dak., has been of little value to waterfowl in recent years because of the rapid run-off. In the past year, however, four huge dikes were built to create vast expanse of marshland extending along the course of the old river channel for 15 or 16 river miles. Now, with approximately 11,000 acres of water permanently assured, the number of waterfowl has increased from a very few last year to an estimated population of 250,000 in the spring

of 1936. Construction included 830 small islands and several large earth ones to provide nesting sites for waterfowl, 62 nest boxes for the hole-nesting varieties of ducks, 158 fish shelters, 2 large combination wave breakers and fish shelters, and a number of spawning racks intended to serve also as shelter for small aquatic life. Windbreaks were erected on approximately 115 acres of denuded areas to check soil erosion and also to conserve moisture by piling up drifts of snow.

Trees and shrubs to the number of 22,762 were planted on the area, the majority being transplanted from the river bottom to higher ground along the marsh borders. Some 5,000 of them, representing 18 varieties, were used in the landscaping of the headquarters site. Food and cover provision consisted in the planting of 22,320 pounds of seed and tubers, in addition to sowing 148 acres of land to barley. Water millet and burweed seeds weighing 8,785 pounds were gathered and shipped to various other refuges, in exchange for which the Lower Souris received some 300 pounds of seeds not readily obtainable there.

The grounds at the headquarters site were raised to proper elevation by the hauling in of large quantities of earth, and construction of gravel driveways and service courts was begun. A 51-foot ditch was dug, and pipe lines and conduits were laid. An equipment shed for tractors and other machinery was constructed, and a large goose pen was built near the headquarters building.

C. C. C. enrollees assisted local telephone men in constructing a two-wire line from headquarters to Upham. A large-scale filtration plant was built at the camp site to render the marsh water suitable for camp use. Many miles of old and valueless fencing were removed and a number of old buildings wrecked to provide material for the development work. Some grading also was done toward the building of a patrol and work road.

An inventory of the plant and animal life on the Lower Souris Refuge was undertaken, and adequate records for future comparative work were compiled. A study was made of the extent of damage done by crows to the duck population, and research was undertaken to determine the status of each species of predator present.

No ducks were seen on the refuge during the winter, but most of the upland game birds (sharp-tailed grouse, prairie chickens, ring-necked pheasants, and Hungarian partridges) survived the winter very well.

UPPER SOURIS MIGRATORY WATERFOWL REFUGE

The Upper Souris Migratory Waterfowl Refuge, N. Dak., lies on the Souris River, a stream coming south out of Saskatchewan, Canada, meandering through part of one of the great hereditary nesting areas of the Northwest, and then returning north into Manitoba. Prior to the disastrous drainage activities of the early part of the century, hundreds of duck hunters visited the section every fall, and the local prosperity came in part from catering to their wants. To furnish a more uniform water supply for this refuge and also for the Lower Souris Refuge, which lies about 70 miles downstream, a huge storage reservoir was completed under contract during the year. The principal dam, which is about 27 feet high, required 302,000 cubic yards of earth fill and has concrete and steel outlet works and a separate spillway of rubble and reinforced concrete.

This dam and its smaller supplementary water-control devices furnish an excellent example of the multiple benefits that arise from stream control even though designed primarily to create optimum conditions for waterfowl. This major reservoir, with a storage capacity at normal water level of about 112,000 acre-feet, will improve the sanitary conditions of several valley towns, which in the past have not had enough flowing water at certain seasons to flush treated sewage from the river channel. Paradoxically, with the melting snows and heavy rains of spring these same towns have suffered from serious floods, because of the slight fall of the valley and the meandering course of the river. A storage dam of the size of that now installed would have controlled all but three of the floods known to have come down the valley and would have minimized the damage done by these three.

Two C. C. C. camps, working under the direction of the Bureau, have provided facilities necessary to the biological development and administrative effectiveness of the refuge, including construction of dams, dikes, ditches, spillways, and two outlet structures in the development of an 8,000-acre marsh area below the principal storage dam; erection of three equipment storage structures, a garage, and a lookout tower; installing a water supply, and a sewage and waste disposal system; building patrol and service roads and other trails; developing

nurseries for trees and shrubs; collecting some 30,000 pounds of seeds of food and cover-producing plants for use on the refuge and for distribution to other areas not so favorably supplied; planting some 12,000 trees and food patches aggregating 252 acres; protecting nearly 8,000 square yards of dikes and dam surface with riprap; placing refuge markers along 118 miles of boundary; and razing undesirable structures and salvaging thousands of feet of useable lumber. Headquarters building construction, under contract let after competitive bidding, was completed during the year. The structures consist of a residence, and a service building combining office, garage, and workshop.

On a deep-water part of the 30-mile reservoir a recreational area has been developed to provide facilities for swimming, canoeing, fishing, and picnicking. The new reservoir will carry great numbers of fish, including bass, pickerel, perch, sunfish, and bullheads.

Because of the new deep-water storage reservoir, the Upper Souris Refuge was particularly important during the year as a resting place for the intensively hunted diving ducks, many of which, including canvasbacks and redheads, nested there, as well as pintails and mallards. Canada geese, swans, and white pelicans in large numbers also visited the area. Since water was seasonably distributed from the reservoir to create favorable conditions for aquatic-plant production and growth of nesting cover in the marsh areas below, the nesting conditions were ideal. With the onset of northern blizzards thousands of sharp-tailed grouse moved in from Canada, and the natural food supply, augmented by artificial plantings, supported also a large population of pheasants, Hungarian partridges, and pinnated grouse, as well as three species of rabbits, some lynxes, a number of beavers, and an occasional deer. A private herd of 60 to 80 buffalo was maintained on a part of the refuge to which title has not yet become vested in the Federal Government.

MALHEUR MIGRATORY BIRD REFUGE

The condition of the Blitzen River, the only source of supply to the Malheur Lake, Oreg., was more favorable than for several years past, though no water whatever reached the Malheur Migratory Waterfowl Refuge from the Silvies River on the north, which in former years had a greater flow than the Blitzen. To conserve the meager water supply, an extensive dike and canal system was developed and largely completed during the year entirely by the C. C. C. camps. The dike, which is 70 feet wide at the base and 20 feet at the top and runs in a north-and-south direction for 10 miles from a point east of the mouth of the Blitzen and Silvies Rivers, was approximately 75-percent complete at the end of the year and served to prevent the waters of the lake from overflowing eastward over a 15,000-acre area, thereby checking evaporation losses. When completed, the dike will further serve as a patrol and work road for the eastern part of the refuge. To distribute the waters of the Blitzen River, at the south end of the refuge a reinforced concrete dam with two spillways was constructed with a fishway of four concrete pools, having a jump of 1 foot between each, to provide easy passage of trout up or down stream.

Because of the dilapidated condition of all water-control structures and canals in the newly acquired Blitzen Valley unit, approximately 4 miles of temporary levees were quickly thrown up to hold a reasonable quantity of water in the most important waterfowl areas. These will be made permanent as soon as soil and water conditions permit. The main ditch along the west boundary of the Blitzen unit was reconstructed for a distance of 10 miles and 2½ miles of new ditching were added. Necessary telephone lines were constructed, including one 27 miles long from Burns to Narrows.

Stone headquarters buildings were begun in September, and at the end of the fiscal year more than 235 tons of rock had been quarried and hauled 22 miles to the building site. Two service buildings, an oil house, and a storage shed were constructed of salvaged materials, and an old ranch house was repaired for use as temporary office headquarters.

Approximately 7,600 rods of boundary fence in the Blitzen Valley unit have been repaired, about 6 miles of new five-strand barbed-wire fence have been completed, and several miles of proposed fence lines have been surveyed. One new bridge has been constructed, two old ones have been put in good condition, and roads have been graded and graveled.

In the nursery program 2,416 trees, principally hackberry, Russian-olive, Russian mulberry, Lombardy poplar, European larch, yellow pine, and caragana, with lesser number of mulberry, elm, plum, locust, and maple, are being suc-

cessfully maintained in the nursery, as well as 1,436 cuttings of golden willow, Carolina poplar, Lombardy poplar, black mulberry, and black locust, and 133 shrubs. In addition, 1 ton of barley and 1 ton of wheat were sown in suitable areas in the Blitzen Valley to be left unharvested as an addition to the refuge's supply of natural waterfowl food.

During the fall of 1935, some 10,000 birds were banded and excellent data on migration recorded. This work was resumed early in the spring when 499 ducks, chiefly mallard and pintails, were banded.

Increased precipitation during the winter made conditions for waterfowl better than for 10 years or more, with the result that redhead and ruddy ducks nested on the refuge in large numbers, as also did mallards, gadwalls, cinnamon teal, pintails, shovelers, and a few pairs of blue-winged teal. Approximately 2,000 Canada geese spent the winter there. Shore birds nesting in some numbers included the long-billed curlew, Wilson's snipe, avocet, western willet, Wilson's phalarope, killdeer, and spotted sandpiper. Other birds that add interest to the refuge are sand-hill cranes, white pelicans, black terns, Forsters' terns, California and ring-billed gulls, egrets, black-crowned and Treganza's blue herons, white-faced glossy ibises, and various grebes.

About 100 mule deer frequented the refuge. These animals are common on surrounding ranges adjacent to the Blitzen Valley section. Antelope have been seen on and in the vicinity of the refuge at all seasons. With the drying up of the open range late in summer, their numbers increased in proportion to the seriousness of the drought, as they found ample food and water in the Blitzen Valley.

The refuge is well stocked with some of the more valuable fur bearers, including beavers, raccoons, mink, and, in smaller numbers, muskrats. Beavers were well distributed along some 30 miles of the Blitzen River, living in bank burrows and cutting some of the abundant growth of willows and other plants for food. Although only a pitiful remnant remains of the once great numbers of muskrats, it is expected that they will increase under water-control operations.

Though the status of upland game birds on the refuge is not yet satisfactory, the ring-necked pheasant, introduced into Harney County in 1913, has increased fairly well in favored localities, one of which is the fields of the P Ranch. European partridges, also introduced into the area a few years ago, have increased in numbers but are not yet plentiful. Sixteen Oregon ruffed grouse, which had been hand raised at the Oregon State Game Commission's Experimental Farm, were liberated last spring in a brushy area of the P Ranch unit in an effort to colonize this species on the refuge.

CAPE ROMAIN MIGRATORY BIRD REFUGE

The vast salt marshes of the Cape Romain Migratory Bird Refuge, S. C., through which run numerous creeks, continued to harbor a wide variety of birds, which attracted large numbers of visitors during the year from all parts of the United States, armed with cameras and field glasses, even during the hunting season elsewhere. The concentration of waterfowl was unusually heavy, more than 100,000 ducks enjoying the complete safety afforded by the area and its wealth of marsh and aquatic plants.

Willets were numerous on the sand beaches. Approximately 440 pelicans, 3,000 black skimmers, and 5,000 royal terns were nesting at the end of the year on the south end of Cape Island, and more than 600 Louisiana and snowy heron nests were counted along the northern shore of Bull Bay. Oyster catchers nest on the shell knolls throughout the entire area. Throughout the marshes great numbers of Clapper rails were found nesting, as were Wilson's plover in lesser numbers along the beaches. Long-billed curlews, dowitchers, black-bellied plovers, sandpipers, knots, sanderlings, and turnstones were among the migrant shore birds that frequented the refuge in large numbers during the winter, and about 50 marbled godwits also remained there at that season. About 5,000 Hudsonian curlews used the refuge during their spring migration. About 1,500 young birds were banded on the refuge during the summer, mostly black skimmers, brown pelicans, royal terns, and oyster catchers. Several of these species are in need of all the protection they can get, and they find in the Cape Romain Refuge a haven of safety.

A biological change of note during the year resulted from the introduction of fresh water through the recently constructed intracoastal canal, which leads directly from the northern section of the refuge to the South Santee

River. To benefit by the change in physical environment, wigeongrass and saltmarsh bulrush were planted in the fresh-water and brackish sections. Surveys were completed for the creation of two ponds to provide fresh-water aquatic foods and thus greatly increase the effectiveness of the refuge.

Structural developments during the year were confined mainly to the erection under private contract of a combined residence, office, and laboratory building and a service building to provide a storeroom, workshop, laundry, pump room, and garage. A bulkhead was built by C. C. C. enrollees to protect the filled-in parts of the headquarters site from erosion by waters of the channel.

The purchase of Bull Island during the year increased the size of the Cape Romain Refuge by 5,591 acres and made the water frontage of the combined units about 25 miles. In addition to shorebirds, mallards, black ducks, and wood ducks in large numbers find haven on the island. Some of the most frequently observed migrants on the island were the great blue heron, American egret, snowy heron, green heron, Louisiana heron, black-crowned night heron, long-billed and Hudsonian curlews, marbled godwit, turnstone, laughing and ring-billed gulls, plovers of many species, oyster catchers, brown pelicans, and the royal tern. Employees who had been in charge of the area for many years prior to its acquisition as a refuge report a marked increase in shore birds in general, particularly the Hudsonian curlew, marbled godwit, turnstone, and the smaller plover. Willets nest in the refuge and appear to have increased 10 to 15 percent over last year's numbers.

Bull Island is outstanding as an area in which wildlife is still abundant. Deer and many species of fur bearers are commonly observed. A colony of 50 to 75 otters is on the increase, records showing that when observations were made some 7 years ago only one otter was seen.

Major improvements made during the year, in cooperation with Army Engineers, for maintaining the island's natural attractions to wildlife and facilitating its administration as a sanctuary include construction of a dam to exclude salt tides from a basin formed by a creek and its marshes and to add approximately 1000 acres to the already existing 800 acres of fresh-water ponds and marshes and dredging of two boat channels, one on Bull Island itself and the other on the mainland, where a landing site was acquired.

Water and marsh areas of the island produce sufficient quantities of duck-food plants, including banana waterlily, wigeongrass, bushy pondweed, sago pondweed, and bulrush, to supply other nearby Federal refuges under the development. Experimental work on cattail control was conducted throughout the year.

LACREEK MIGRATORY WATERFOWL REFUGE

Four dams, complete with spillways and gate structures, creating 3,698 acres of flooded area with approximately 11,366 acre feet of storage, and a series of six lateral dikes and some nesting islands were built under contract at the Lacreek Migratory Waterfowl Refuge, S. Dak. In spite of unusually severe weather conditions and some opposition to the project, the work was completed in April. The lateral dikes, construction of which involved the moving of 500,000 cubic yards of earth, create additional controllable marsh areas, small open channels, and islands and form a moat around the main nesting areas to serve as a fire guard and discourage invasion by house cats, coyotes, skunks, and other predators.

Development work included the planting of 2,000 jack pines from nursery stock, seeding a 20-acre tract to barley as a feed patch for upland birds, and sowing throughout the marshes sago pondweed, giant burweed, wild rice, wild millet, swamp smartweed, and bulrush.

During migration about 2,000 Canada geese and small numbers of Hutchins's and snow geese and thousands of ducks used the refuge, and other thousands of ducks, shore birds, herons, and others remained to nest. Birds banded included 64 pintails, 19 mallards, 20 blue-winged teal, 1 green-winged teal, 6 baldpates, and 1 redhead, a total of 111. During the winter a few redheads died from lead poisoning, and some birds, notably shovelers, were lost by freezing.

Some destruction of ducks by skunks, minks, weasels, raccoons, hawks, and owls was noted, but by far the greatest damage to birds was done by snapping turtles, 63 of which were destroyed by rifle. During patrol activities, evidence was noted that muskrats were burrowing into dikes, and a trapper having a special permit to work on a part of the refuge took 1,022 muskrats in addition to 100 pelts taken by hired labor and shipped to the Bureau.

SAND LAKE MIGRATORY WATERFOWL REFUGE

The Sand Lake Migratory Waterfowl Refuge, S. Dak., has an area of 21,160 acres with a 65-mile shore line and a flooded portion, when water is flowing from the spillways of the dams at both Sand and Mud Lakes, of approximately 10,089 acres. The total area of islands, both natural and artificial, is 997 acres, and they have a shore line of 11 miles.

Permanent buildings constructed under contract include a residence, barn, boathouse, garage, a 100-foot tower, and a service building housing an office, laboratory, shop, storeroom, and a water pump and power plant.

An extensive work program carried out by a C. C. C. company included construction of a dam 945 feet long, 110 feet wide, and 9 feet high, with a concrete spillway, to form a lake about a mile and a half long and varying in width from 30 to 300 feet. This small lake will serve as a demonstration area for experimenting with and displaying aquatic food plants, for a model nesting area, and as a field for the observation of waterfowl. A bridge across the pool will increase its value for these purposes. The camp also built three permanent structures—a dry-storage and a wet-storage cellar, and a large garage.

Six large nesting and resting islands as well as 20 smaller nesting mounds were constructed. Crescent-shaped islands, approximately 400 feet long, with a 75-foot top, and a bottom width of 175 feet, will be 3 or 4 feet above water when the lakes are full. They serve as a buffer against wind action and create quiet intermediate pools, in which smaller circular islands were placed. Various planting experiments with bulrush roots and seeds were conducted, and during the spring 64 cubic yards of gravel were placed on top of these islands to provide a supply of grit for the waterfowl.

Preparation for fencing the refuge was a major camp activity and included peeling and trimming 24,000 posts, shipped from the Black Hills by the Forest Service, and constructing vats for treating them with creosote. Thirty buildings on the refuge, so old as to be beyond use, were razed and all usable materials, together with that from dismantled fences, salvaged. Six of the better buildings were moved to the camp for immediate use.

An outstanding achievement of the C. C. C. camp was the gathering of a huge supply of seeds and aquatic plants as well as of cuttings, seedlings, and sprouts of cover plants. This material was partly for use on this refuge, but 1,100 pounds of sago pondweed seed and 105 bushels of bulrush seed were shipped for planting on other reservations.

A survey was made of trees and shrubs on the refuge as a basis for later tree-planting and cover-development projects, and great quantities of seedlings, roots, and cuttings of chokecherry, plum, grape, and aspen were gathered for planting.

The Shelterbelt Division of the Forest Service furnished the refuge approximately 1,200,000 shrubs, for lining out in a 10-acre nursery, which was fenced and developed by the C. C. C. camp. In addition about 160,000 seedlings were used in planting approximately 10 miles of clumps and shelter rows and about 20 miles of four-row strips.

Other important accomplishments by the C. C. C. camp were the landscaping and planting of trees and shrubs around the headquarters buildings and the raising of grain to feed the thousands of waterfowl that nest on the area or visit it during migration. Eight hundred acres were sown to barley, wheat, millet, Sudan grass, sweetclover, corn, and soybeans. This food supply will be supplemented by the retention of about 1,000 acres that were in clover and alfalfa when the area was acquired.

Although drought made the water supply at Sand Lake deficient, the area was frequented by a surprising number of waterfowl and shore birds. The flight of blue and snow geese was the most conspicuous event of the spring season, approximately 25,000 birds about evenly divided between the two species having been seen in mid-April. Thousands of Franklin's gulls remained over a month, and competent observers stated that the shore-bird flight was larger than any previously seen on any of the inland lakes. Marbled godwits, avocets, willets, and northern phalaropes were noted during migration, and on one day at least 1,000 stilt sandpipers visited the refuge.

WAUBAY MIGRATORY WATERFOWL REFUGE

A group of administration buildings was constructed on the Waubay Migratory Waterfowl Refuge, S. Dak., the surrounding ground was cleared for

planting of seeds and cuttings, and 3 miles of old fence were removed. The planting included pine seedlings in groups; barley, corn, and wild-millet seed were sown in suitable spots; and buffaloberry seedlings and golden willow cuttings were planted around the pot holes which for the most part had been made barren by drought.

Mallards, pintails, and Canada geese were seen on the refuge area, but in fewer numbers than normal in other years. Residents of the nearby towns of Waubay, Webster, and Greenville expressed great interest in the refuge and pledged their aid in the event of a fire on the drought-stricken area or on the surrounding territory. Class groups of high-school students of the three towns made frequent visits to the refuge.

TREMPEALEAU MIGRATORY WATERFOWL REFUGE

At present comprising 708 acres of upland and already developed into a valuable unit, the Trempealeau Migratory Waterfowl Refuge, Wis., will be enlarged by 5,400 acres of waterfowl marsh now in process of acquisition. One C. C. C. camp was engaged in development work for approximately 5 months, and at the end of the year a detail of 20 C. C. C. men was employed in construction. They planted several thousand berry bushes and shrubs, lined out some 30,000 additional young trees and shrubs in a nursery, and planted food patches to make the refuge more serviceable to upland game. Attracted by the protection afforded and the management practices employed, a herd of about 15 deer has taken up residence on the refuge. Headquarters buildings completed during the year consisted of a family cabin, a public lodge, and a service building, including shop, storeroom, laboratory, and office.

UPPER MISSISSIPPI RIVER WILDLIFE AND FISH REFUGE

Canalization and impoundment of water in connection with the navigation-improvement program on the Mississippi River is causing profound biological changes in the Upper Mississippi River Wildlife and Fish Refuge. Although it is impossible to predict definitely the changes in the flora and fauna, earlier studies made by the refuge personnel and continued during the past year forecast improved conditions generally for all forms of wildlife on the refuge. Observations thus far indicate that a satisfactory growth of aquatic plants is developing where the water has been impounded, particularly in the newly created pools above dams nos. 4 and 5.

Water conditions during the fall were much improved over the preceding 2 years, and a corresponding increase in the number of wildfowl passing down the Mississippi Valley flyway was observed. There appeared to be a substantial increase in the numbers of pintail and mallard ducks, and scaups seemed to be present in approximately the same numbers as in the preceding year. The probability is that there were more wild ducks killed during the past season on the 20-mile stretch of the river that encompasses pools nos. 4 and 5 than ever before. Water conditions were ideal, and with an abundance of food available heavy concentrations of birds were attracted to the area.

Regulatory activities continued to be of major importance on the refuge. The regular force of reservation rangers, supplemented during the periods of the heaviest waterfowl concentrations by deputies, proved adequate for the patrol work. The absence of any serious cases of trespass is noteworthy and indicates the development of a wholesome public respect for the inviolate areas. Cooperative relations were maintained with conservation agencies of the four adjoining States, and substantial progress was made in reducing the number of law violations. During the year 13 cases were presented to the Federal courts, 11 were terminated, and 10 (including those of the previous year) are still pending. Agents apprehended 20 violators of the Migratory Bird Treaty Act, and with the termination of 26 such cases only 4 awaited trial. Of the five Migratory Bird Hunting Stamp Act cases reported three were nol-prossed and two were left pending in the Federal courts. During the year 21 violators of State fish and game laws were apprehended, and all the cases were terminated, resulting in jail sentences, fines, or both.

The planting of food patches was continued and has proved satisfactory in supplying food to upland game birds during the winter months. As the major part of the refuge is subject to overflow, only small sections can be used for food and cover plants.

Winter feeding of upland birds was continued as heretofore. Large numbers of ring-necked pheasants and quail were concentrated at the various feeding stations. Various types of artificial feeding stations have been used successfully, and all were kept provisioned even during the periods of heaviest snowfall. Cooperation in distributing feed was extended to several conservation organizations and State officials, and this was efficacious in aiding large numbers of birds to survive the unusually severe winter.

Muskrat trapping was permitted from March 25 to May 13 in the Minnesota section of the refuge, and although unseasonably cold weather and heavy ice made trapping conditions extremely unfavorable, satisfactory catches were reported by the majority of trappers. The number of fur animals appears to be ample to produce a large crop next year, and with the maintenance of closed areas within the refuge after the various locks and dams have been completed and satisfactory food and living conditions are assured, it should be possible to permit open seasons regularly.

BEAR RIVER MIGRATORY BIRD REFUGE

At the Bear River Migratory Bird Refuge, Utah, work was continued during the year for improving large salt-flat areas, which, by the construction of many miles of dikes and necessary water-control structures, will be flooded with fresh water and kept at favorable levels. Drag lines and a full C. C. C. camp were used, and the C. C. C. workers, operating in shifts and using 30 trucks, hauled hundreds of thousands of yards of riprap materials from adjacent gravel pits for the protection of the dikes. Nesting islands of soil and rock have been constructed, truck and foot trails built, many miles of fences erected, boundary markers established, new marsh areas (especially where waterfowl food-producing plants were not abundant) planted with seeds obtained elsewhere on this or other refuges, and water-control structures in both the previously existing and the new dikes protected by rock riprap, the materials for which were hauled from the adjacent mountains. In general the area has been so developed as to make it of greater attractiveness to waterfowl.

During the fall hunting season 912 hunters took 2,770 waterfowl on such areas within the refuge boundaries as were open to shooting and the kill was approximately 73 percent less than the average for the 3 preceding years.

A serious outbreak of western duck sickness occasioned a loss of about 7,000 birds, but, since it is conservatively estimated that approximately 25,000 ducks were produced on the refuge during the year, there was a favorable balance. Although there was a decided increase in the number of mallards on the refuge, pintails and green-winged teals hold first and second places, respectively, for relative abundance there. An important study conducted on the refuge relates to habitat factors, principally vegetation and soil conditions, and an analysis of their potential relationship to outbreaks of the duck sickness.

COOPERATIVE REFUGE DEVELOPMENT AT THIEF LAKE

A 30,000-acre refuge for birds at Thief Lake, Marshall County, Minn., owned and administered by the State, has been developed during the past year in cooperation with the Biological Survey, by means of a C. C. C. camp established in October. Forty nesting islands were thrown up on flats bordering the lake, and 200 brush-pile nesting sites and 110 fish shelters were built in the lake from willow growths. About 20 acres were sown to grain, and marsh and aquatic plantings included wild rice, pondweed tubers, wild millet, smartweed, and burweed. In addition, 42,000 seedlings of jack pine and white spruce were set out and 4,000 trees and shrubs were transplanted from nearby woods to provide food and cover for game. Ten resident species of waterfowl were noted on the area and about 25 grouse per section, but only 60 Hungarian partridges and 7 pheasants in all. During migration Canada geese, snow geese, blue-winged teal, shovelers, and white-winged scoters were noted.

BIG-GAME PRESERVES

Substantial progress was made during the year toward restoring and preserving ranges for antelope, deer, mountain sheep, sage grouse, and other species of upland game in connection with the establishment under the Taylor Act of 1934 of grazing districts in 11 Western States. Ten or more of these ranges are under consideration in cooperation with the Department of the Interior,

and Executive orders for their establishment were pending at the close of the fiscal year. Two outstanding projects reserved from the public domain by Executive order were the Desert Game Range in Clark and Lincoln Counties, Nev., with a gross area of 2,022,000 acres, primarily for Nelson's Rocky Mountain sheep but inhabited also by deer and sage grouse; and the Hart Mountain Antelope Refuge, including 495,536 acres in Oregon and 528,794 acres in Nevada, adjoining the existing Charles Sheldon Antelope Refuge on the north, east, and south. The Nevada area has been placed under administration in connection with the present Charles Sheldon Refuge, as large numbers of antelope from both the Charles Sheldon and Hart Mountain Refuges winter in this area. The addition of approximately 3,800 acres of public lands to the Charles Sheldon Refuge on the west, by another Executive order, not only will afford protection to mule deer in a rimrock area but also will greatly facilitate administration and maintenance of the boundary fence.

The number of big-game animals on fenced preserves administered by the Bureau was 2,356 at the close of the year, as compared with 2,406 1 year ago (table 4). Some surplus stock was disposed of at various preserves and some new stock was received on several, as discussed under separate headings.

TABLE 4.—*Animals on fenced big-game preserves maintained by the Bureau of Biological Survey* [1]

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total [2]	Young born in calendar year 1935 [3]		
					White-tailed	Mule		Buffalo	Antelope	Mountain sheep
National Bison Range, Mont.	486	[4] 108	------	39	[4] 38	[4] 160	831	50	------	16
NiobraraGame Preserve,Nebr.[5]	138	[4] 39	29	--------	6	5	217	26	3	--------
Sullys Hill Game Preserve, N. Dak.	21	[4] 31	------	--------	17	------	69	1	------	--------
Wichita Mountains Wildlife Refuge, Okla.[5]	341	[4] 245	------	--------	[4] 653	------	1,239	50	------	--------
Total	986	[4] 423	29	39	[4] 714	[4] 165	[2] 2,356	127	3	16

[1] With the exception of those of young born, figures are for June 30, 1936.
[2] Including estimates.
[3] Young of elk and deer omitted, as in most cases only estimates could be made, but during the calendar year approximately 76 elk calves, 20 fawns of mule deer, and 117 of white-tailed deer were counted on the preserves.
[4] Estimated.
[5] There are also 121 Texas longhorns on the Wichita Mountains Wildlife Refuge, Okla., and 6 at the Niobrara Game Preserve, Nebr.; 20 calves were born on the Wichita Refuge during the calendar year 1935.

NATIONAL BISON RANGE

Though the past winter was extremely severe at the National Bison Range, Mont., and throughout that section, the temperature at times falling to –40° F., the buffalo and elk came through in good condition. Up to the early summer of 1936, 76 buffalo calves had been born and a satisfactory increase in the elk was indicated by the number of calves already seen. The condition of the mule deer and white-tailed deer is good, though severe weather and an infestation of the deer botfly caused heavy losses among the former. The number of deer fawns born was not known at the close of the fiscal year but 34 had been noted. Though mountain sheep have not thrived on the range, 12 lambs were in the small band at the close of the year and appeared to be in healthy condition; heretofore about the middle of July they had frequently suffered heavy losses from pasteurella pneumonia. In spite of hot and dry weather up to the middle of June later rains benefited the grasses, and there is every indication that the game animals will have sufficient forage next winter.

Surplus animals disposed of at this preserve included 33 buffalo, 7 elk, and 23 mule deer, 4 of the buffalo and all the deer having been donated to Indians of the Flathead Agency for use as meat.

Pheasants, Hungarian partridges, ruffed grouse, and blue grouse are doing well on the Bison Range, and nesting conditions for all these birds have been favorable. Those that could be reached were fed during the severe winter

weather. Employees at the Bison Range plowed out nearly 4 miles of road through the snow to the largest of the nearby warm springs, where 8,000 ducks congregated, and fed them an average of 450 pounds of wheat a day. Cooperators in the locality assisted in feeding the birds at other points. Nesting conditions have been favorable for a limited number of ducks, and a satisfactory hatch has been noted.

Coyotes, though numerous on the preserve early in the year, were satisfactorily reduced through the efforts of a Government trapper. The C. C. C. camp at the Bison Range is accomplishing much in the way of rodent control, range revegetation, road construction and improvement, painting buildings, reducing the fire hazard over a large area, and campground development. An unusually large number of persons visited the range during the latter part of the year.

ELK REFUGE

One of the first projects to be approved under the $6,000,000 fund for refuge acquisition was the enlargement of the Elk Refuge, near Jackson, Wyo., for the care of the southern Yellowstone herd of elk, which winters in the Jackson Hole section. The acquisition of most of the area south of the Gros Ventre River, east of the Jackson-Moran Highway, and north of the town of Jackson has long been considered essential to good management of the herd. The consolidation of this area will eliminate many complications that have heretofore resulted from trespass by the elk on private property and will aid in providing adequate winter feed and forage. The program further involves the leasing of 3,000 acres from a land-holding company, the reserving of 3,200 acres of public lands by Executive order, and the purchase of approximately 15,000 acres of privately owned lands within the boundaries of the area. At the close of the year the 3,000 acres had been leased, options approved for the purchase of 8,000 acres, an Executive order was pending describing the 3,200 acres of public land that have been located within the exterior limits of the refuge, and negotiations were under way for the acquisition of the remaining alienated property. The completion of this project will mark the culmination of an outstanding effort for the perpetuation of one of the great herds of this unique American game animal, the Rocky Mountain elk.

In order to insure sufficient winter food for the elk, 1,983 tons of hay were purchased and 1,535 tons were harvested on the refuge during the summer of 1935. These quantities, in addition to 35 tons left over from the previous season, made 3,553 tons available for the winter of 1935–36. In addition there were also on hand 268 tons of cottonseed cake.

It was found by a census taken in 1935 that the herd had increased beyond the optimum number decided upon as practicable to maintain. To reduce it to the carrying capacity of range and the winter feed available the State Game Department of Wyoming allowed greater hunting privileges for the season than had been in effect for several years, and as a result the hunters in the Jackson Hole section took approximately 6,300 elk. To further reduce the herd, the State game department during December and the early part of January slaughtered 548 animals on the refuge and disposed of the meat through commercial channels. A census of this elk herd, in March 1936, in cooperation with the Forest Service and the State game department, showed a total of 18,920 animals, 4,040 of which were on the feeding grounds. Elk wintering in the outlying districts were counted from an airplane.

Extremely severe weather did not arrive until the early part of January, but during the next 2 months there were almost continuous winds and snowstorms, with a greater snowfall than in years. Feeding the elk began on February 5 and continued until April 19. Approximately 4,200 animals were fed on the refuge, some 5,000 less than during the previous winter, a difference, no doubt, due to the heavier kill by hunters in the vicinity of the refuge.

During the period of feeding approximately 1,380 tons of hay were consumed, so there remain 2,173 tons for next winter. On three feeding grounds south of Jackson the State game department fed about 1,200 elk with hay it had purchased and approximately 2,000 elk with cottonseed cake and baled hay that it had stored in sheds in the Gros Ventre section.

Of the elk fed on the refuge, 93 died from disease and other causes, but the percentage of loss among elk that wintered on the open range as well as those on the feeding grounds was much less than a year ago, probably because of the much better growth of forage on the ranges and the comparatively short

feeding season. Snow was still deep in the section at the last of March, but during the first week of April warmer weather prevailed and by the end of the month the snow had almost disappeared. Owners of the lands being added to the refuge have given the Survey the right to immediate occupancy, and the hay lands involved are being irrigated. It is estimated that the hay crop for this year will be increased by about 675 tons by harvesting on these new lands.

Through enlargement of the refuge the Bureau has also become the custodian of a considerable colony of beavers that inhabit lands along the Gros Ventre River, an ideal place for their preservation in large numbers.

The increase in waterfowl on the refuge during the fall and spring migrations was noticeable.

In addition to the regular maintenance work carried on at the Elk Refuge from year to year, 3,400 fence posts and 300 braces were cut and hauled during the winter from the adjacent national forest, to be used in constructing 8½ miles of woven-wire elk-proof fencing to aid in retaining the animals on the lands recently acquired and prevent their trespassing on private property.

SULLYS HILL GAME PRESERVE

The buffalo and elk survived the severe winter on the Sullys Hill Game Preserve, N. Dak., in fine condition. They were fed plenty of hay during the winter and have thrived on the grass available since the disappearance of the snow.

Three young buffalo were disposed of during the winter. Of the seven beavers received from the Niobrara Game Preserve, Nebr., four survived and appear to be thriving. Efforts have been made to establish these animals on the east end of the small lake within the preserve, where a den has been built for them. Two small dams were constructed in the deer pasture to hold back some of the rapid run-off into Devils Lake, and it is planned to place the beavers there later on. The ponds can be used also as watering places for the deer.

There are no predatory animals at Sullys Hill and few fur animals. Only about half as many geese were noticed during the migration period this spring as last year, though about the same number of ducks were observed.

The effect of the drought has been keenly felt in the vicinity of this preserve, with the precipitation 3.27 inches below normal. Vegetation benefited in the spring from melting snow but has suffered from the small rainfall since that time. There is plenty of pasture, however, for the animals, and with 50 tons of hay carried over from last year sufficient feed is in prospect for the coming winter.

Visitors to Sullys Hill during the year numbered 15,787, with 3,137 cars.

NIOBRARA GAME PRESERVE

Most of the big-game animals on Niobrara Game Preserve, Nebr., are thriving, the buffalo being in exceptionally good condition. Of 34 young antelope obtained in May and June from points in Wyoming and from the State Antelope Preserve in South Dakota, 24 survived and at the close of the year were being raised by hand feeding. Four mule deer fawns were donated to the preserve by the Custer State Park, S. Dak., and three of these survived. Six Texas longhorns were transferred from the Wichita Mountains Wildlife Refuge, Okla., late in the spring, and have adjusted themselves to the new environment. Surplus big-game animals disposed of during the year included 22 buffalo and 12 elk, 25 being for breeding and exhibition purposes and 9 for meat.

Predatory animals and rodents are well under control on the preserve. A few surplus raccoons, skunks, minks, and weasels were removed as a measure for encouraging ground-nesting birds. To protect earthen dams and water-control structures, 118 muskrats were trapped during the year. Seven beavers were taken and shipped alive to Sullys Hill Game Preserve for stocking.

The winter was the most severe on record, with a total of 33 inches of snow during January and February and a temperature averaging —4.2° F. for 36 days; —8° was registered as late as April 3. In spite of deep snows and extremely cold weather no upland game birds were found dead, although quail were so scarce in spring as to suggest that they had been buried under deep snow and starved. Other species apparently were aided in surviving the weather by the food and cover plantings at various points. The prairie chickens and sharp-tailed grouse were much fewer than in the previous winter. A number of mallard ducks wintering on open ponds on the preserve were fed grain during the very cold weather.

Though grazing conditions are not so good as a year ago, due to shortage of rainfall, there will be sufficient forage for the animals.

Work was continued on the improvement projects started in the previous year, other projects have been inaugurated, and much has been accomplished by the members of the C. C. C. camp, including construction of roads that greatly facilitate patrol, completion of two large dams in the north pasture, and creation of a number of small ponds on the west arm that will provide for water storage and accommodate water birds. Other construction work was carried on, and an old house on lands recently acquired was moved near headquarters and is being remodeled for office purposes and for displaying specimens of wildlife, plants, and fossils found on the preserve. A new exhibition pasture for elk was reserved near headquarters, and more than 400,000 trees were planted over the preserve during the spring. With the new lands added the area of the preserve is now approximately 20,000 acres.

CHARLES SHELDON ANTELOPE REFUGE

A drought that had prevailed for more than a decade over the northern part of Nevada, in which the Charles Sheldon Antelope Refuge is located, was broken during the winter of 1935–36 with a precipitation of 13 inches, the greatest in a score of years, the normal precipitation being approximately 8.5 inches. As a result, the springs have been replenished, forage assets materially increased, and food and cover for wildlife greatly improved. Especially noticeable has been the reappearance of bitterbrush, chief food of the mule deer, and the reproduction of the quaking aspen, which, several years ago, was in danger because of water shortage and overbrowsing by livestock.

The 528,794 acres of public domain adjacent to the refuge (p. 49) is under joint control of the Departments of Agriculture and the Interior, but will be administered by the Bureau in connection with the original Charles Sheldon Refuge. This area comprises a large part of the winter range of the antelope of both the Charles Sheldon and Hart Mountain Refuges. If favorable moisture conditions prevail, with the regulation of grazing by livestock, these ranges should be speedily restored.

Numerous improvements have been accomplished by the C. C. C. camps that have been stationed on the refuge during two camp periods. One camp began activities in June 1935 and continued through October, when it was evacuated for the winter, but another resumed operations in May 1936. Improvement projects completed or under way include construction of a new entrance road to the refuge and 8 miles of fencing, with 5 miles of old fencing repaired, 50 miles of telephone line, and about 500 check dams in the major eroded drains; erection of a cottage to house an assistant; improvements at the springs for water conservation; planting of willows in wet places near springs and in creek bottoms; and landscaping the headquarters site and the entrance to the refuge.

Predatory animal control work by one Federal hunter removed 127 coyotes and 28 bobcats from the 48 square miles included within the refuge, and 13,000 acres were treated for the control of pocket gophers and ground squirrels.

Both antelope and mule deer have shown a fair increase in numbers. Sage grouse have been on the decrease throughout the district, but several large broods of chicks have been seen within the refuge, in places where food, cover, and water conditions are favorable. Improved natural conditions following the elimination of livestock have made the refuge more attractive to migratory insectivorous and song birds, more than 100 species having been noted. Wild fowl have begun to use the small lakes and ponds on the refuge and for the first time several teal nested there this year. With the bountiful moisture supply and the improvement program, the Charles Sheldon Refuge has shown the greatest single year's advancement since its establishment.

WICHITA MOUNTAINS WILDLIFE REFUGE

Under provisions of the Agricultural Appropriation Act for 1937, approved June 4, 1936, the former Wichita National Forest and Game Preserve in Oklahoma was transferred to the administration of the Bureau of Biological Survey as the Wichita Mountains Wildlife Refuge. Extensive investigations of the life histories of game animals and birds have been inaugurated and other experiments are planned, as well as research that should yield valuable information bearing on the perpetuation of the wildlife of the Great Plains.

Newly created lakes have resulted in a wider distribution of deer, wild turkeys, and quail on the refuge and in increased numbers of waterfowl and other species of migratory birds. The additional pastures provided in the last 3 years have improved grazing conditions for the herds of buffalo, elk, and Texas longhorns, and with the removal or reduction of permitted grazing stock, conditions in general on the open areas are expected to improve. It was most fortunate that a 10-percent reduction in the number of livestock on the refuge as compared with 1935 was effected this year, as drought greatly lessened the forage growth. A heavy June storm provided temporary relief, improving conditions at all the lakes and filling several dams that had been completed during the drought.

Surplus big-game animals disposed of during the year included 64 buffalo and 25 elk. Three longhorn bulls (two 4-year olds and one 3-year old) were brought from Mexico to introduce new blood in the herd, and 12 of the longhorns were disposed of, 6 by transfer to establish a new herd at the Niobrara Game Preserve in Nebraska.

The nesting and hatching season was favorable for wild turkeys, and there appears to have been a satisfactory increase of these birds on the refuge. Almost complete failure of the mast crop, as a result of a late spring freeze, will seriously affect the food supply of both deer and wild turkeys and necessitate the supplying of a considerable amount of grain at feeding stations.

There was a noticeable increase in the number of ducks on the refuge during their seasonal flights and they remained longer than usual; a few pairs of several species also bred on the area. Large numbers of wild geese were seen on the lakes for the first time. Sand-hill cranes also alighted here, and a California gull was seen, a far-inland record for this species. Bobwhite quail were noted in greater numbers than in former years and over a wider area. The lesser prairie chickens planted in cooperation with the Oklahoma State Game and Fish Commission are rapidly becoming common on the refuge.

Lakes and streams in the refuge have been stocked to some extent with fingerlings of various species, through the cooperation of Federal, State, and local agencies, but issuance of fishing permits is being deferred until the new stock has become more abundant.

Two C. C. C. camps located on this area have made many needed improvements, including dam, road, and trail construction, erection of a laboratory and two residences for wildlife technicians, repairs to buildings and fences, the planting of trees, and extensive development of recreational features in the part reserved for public use. The work was inspected by a representative of the Emergency Conservation Work, who considered the accomplishments of the corps of an outstanding nature.

The contract work on the road winding up Mount Scott, the highest peak in the area, has been completed, but some further work will be necessary before the road can be opened to public use. With the aid of a C. C. C. crew, however, it has been possible to allow limited use of the trail on special occasions.

The Wichita Mountains Easter sunrise service, which is held each year under the auspices of an association composed of religious organizations and citizens of nearby communities, was attended this year by considerably more than 100,000 persons. The scenes of the pageant were enacted on Mount Roosevelt, where buildings of a permanent nature have been erected for the purpose. About 2,000 persons from more than a score of cities participated in the pageant.

LAWS ADMINISTERED FOR WILDLIFE CONSERVATION

Federal statutes administered by the Bureau of Biological Survey for the conservation and restoration of wildlife are the Migratory Bird Treaty Act of 1918, protecting birds that migrate between the United States and Canada; the Lacey Act of 1900, as amended June 15, 1935, affecting the shipment in interstate or foreign commerce of wild animals and birds, their dead bodies or parts thereof, and the importation of live birds and mammals from foreign countries; the Migratory Bird Conservation Act of 1929 authorizing the establishment of bird refuges; the Migratory Bird Hunting Stamp Act of 1934 as amended June 15, 1935, to aid in refuge establishment; a law protecting animal life and property on Federal wildlife refuges; and, through the Alaska Game Commission, the Alaska Game Law of 1925.

REGULATORY ACTION

The Migratory Bird Treaty Act regulations for the season 1935–36 provided an open season on migratory waterfowl of 30 consecutive shooting days in each of two shooting zones. In the north zone the season was October 21 to November 19 and in the south zone November 20 to December 19. The regulations as amended did not permit the taking of waterfowl by means of bait or the use of live decoys, from sink boxes (batteries), more than 100 feet offshore at high water or more than 100 feet off protruding vegetation at the time of shooting. The open season on Atlantic coast brant (conditions in 1936 have made it necessary again to prohibit brant shooting in the East) was restored. The hours for shooting waterfowl, coot, and Wilson's snipe were fixed at from 7 a. m. to 4 p. m., standard time, and for rails (other than coot), woodcock, mourning doves, and band-tailed pigeons, from 7 a. m., standard time, to sunset.

The daily bag limit on ducks was reduced from 12 to 10; on rails and gallinules (except sora and coot) from 25 to 15; on coot from 25 to 15; and on snipe from 20 to 15. The mourning dove limit was increased from 18 to 20 and the season on these birds in certain States opened September 21 rather than September 1. The limit of birds in possession was made the same as the daily bag, and interstate transportation was restricted to not more than 1 day's bag in a calendar week.

The regulations for 1935[2] and text of Federal laws for wildlife protection were published in the Service and Regulatory Announcements series (BS–81, 82, and 83), a brief explanation was issued in a mimeographed leaflet (BS–18), and the open-season dates were shown on a poster (no. 56–Bi) issued in August. Other publications relating to the enforcement of conservation laws included the annual bulletin on the game laws (Farmers' Bulletin No. 1755); mimeographed abstracts of State fur laws affecting trapping seasons and bounties (leaflets BS–23 and BS–24, respectively); the annual directory of Federal, State, and Canadian game-protection officials (Misc. Pub. 23); and in the 1936 Yearbook of Agriculture (p. 1157, table 16) on hunters' licenses issued by States, with total money returns for the seasons 1933 and 1934. Many press statements on these and other conservation subjects were issued for educational purposes and to apprise the public of changes in the regulations, including those under the Alaska Game Law (Alaska Game Commission Circ. No. 13 and amendments to Circ. No. 12).

WORK OF GAME-MANAGEMENT AGENTS

For law-enforcement purposes the United States is divided into 8 regions in charge of regional directors, who in addition to other wildlife-management duties supervise the operations of 30 United States game-management agents and 22 deputies. Each agent is responsible for Federal game-law observance, but during an emergency he may be detailed to work elsewhere in the region. Deputy agents are organized into fast-moving units of two to four men each, designated as "flying squadrons." These mobile units travel from one important waterfowl section to another, and their intensive and unannounced patrol has been a salutary influence for law observance. For a better general understanding of duties and to promote efficiency of the organization a conference of all United States game-management agents of the Bureau was held in Chicago, Ill., September 24–26, 1935, at which Bureau policies on game-law enforcement, court procedure, and individual and district problems were discussed.

Enforcement officers are now fully equipped for covering their districts, the facilities provided including cabin-cruiser boats on the larger waterways, lighter boats and outboard motors for inland waters, automobiles for land patrol, and autotrailers for transporting light boats. Game agents and deputies have badges of new design and wear a distinctive uniform when on ordinary patrol, attending court, or representing the Bureau at meetings. The uniform provides immediate identification of the officer and commands greater respect. When on special duty or undercover work the identifying uniform, of course, is not worn.

To aid in the educational program visual information was prepared on game conservation in the form of specially prepared exhibits displayed by the Bureau

[2] Regulations for the season 1936–37, adopted by the Secretary after the close of the fiscal year here reported on, and approved by the President on Aug. 12, 1936, are published in Service and Regulatory Announcement No. BS–84.

at sportsmen's shows and at expositions featuring wildlife subjects. One emphasized the need and value of farmer cooperation by use of uncultivated parts of the farm as breeding, feeding, and resting areas for game and fur animals and other forms of wildlife. Another described land areas being acquired for waterfowl refuges. Two other exhibits stressed the decrease of shore birds and upland game birds and the need for protection through restrictions on hunting and general observance of the game laws and regulations. The number of cases presented by an agent does not necessarily measure his efficiency. It is considered better for waterfowl, as well as for the agent's record, to have his district relatively free from violations than to have a lawless condition with large numbers of court cases prepared.

Although the regulations were more stringent during last season, they were generally respected and obeyed by a large percentage of hunters. The game agents confined their major efforts largely to the vicinity of important concentrations of waterfowl and made special effort to apprehend willful violators known to be trafficking in wild game for profit. Most State game departments have actively assisted in enforcing the Federal regulations, and the value of this splendid cooperation is appreciated highly.

HAZARDS OF THE WORK

Enforcement officers of the Survey at last have the long-needed protection of the Government against killing or assault. By amendment of an existing Federal statute on February 8, 1936, it was made unlawful to interfere with, assault, resist, or impede while engaged in performing his official duties, any officer or employee of the Department of Agriculture designated by the Secretary to enforce any act of Congress for the protection, preservation, or restoration of game and other wild birds and animals. Three persons were arrested for assaulting officers in California, Colorado, and Nebraska. The California case has been disposed of, the defendant being sentenced to serve 6 months in jail. The remaining cases were pending at the close of the year.

APPREHENSIONS OF VIOLATORS

To the diligence and perseverance of the Federal agents can be attributed the marked progress in game-law enforcement made during the year. An outstanding accomplishment was the apprehension in California and Louisiana of ringleaders and their associates engaged in taking waterfowl in close season and in selling the birds. To obtain evidence against such violators is not easy, and arrests were not effected until information had been collected involving not only the chief offenders but those who were engaged in illegal selling on a smaller scale. Successful drives also were conducted in Louisiana in connection with persons selling woodcock and killing robins, and in Illinois, Missouri, and other States for close-season hunting. A number of individuals charged with hunting ducks either by means of bait, over live decoys, or more than 100 feet off shore line were apprehended in Alabama, California, Delaware, Illinois, Maryland, Michigan, New York, Ohio, Oregon, Washington, and Wisconsin.

The regulation limiting automatic-loading and hand-operated repeating shotguns to not more than three shells was also effectively enforced, prosecution having been recommended against 124 offenders for this unlawful means of hunting.

In order to check illegal interstate shipments of quail from Mississippi, carefully laid plans culminated in the apprehension in Illinois of two persons transporting about 200 live birds from the former State. These men were afterward prosecuted in the Federal court in Illinois and fined. Two other Mississippi residents transporting 296 live quail to Alabama apprehended by game agents of the Survey were sentenced to 90 days each in jail.

The forms of violation affecting waterfowl included killing in close season, selling, and purchasing; hunting from automobile and motorboat, over bait and live decoys, before 7 a. m. and after 4 p. m., more than 100 feet off shore or vegetation, and with a gun not properly plugged; killing wood ducks; and possessing swans and offering to sell them. Other offenses were selling snipe and woodcock and killing them in close season; killing dove by means of bait, in close season, and in excess of bag limit; killing sandpipers, plovers, yellowlegs, robins, herons, egrets, and sand-hill and whooping cranes.

Operating on the most meager information that 12 men had killed waterfowl during the close season in North Dakota, an agent quietly investigated and having obtained sufficient evidence for prosecution, brought the cases into State court, where the violators paid fines aggregating $306.

VIOLATIONS AND PENALTIES IMPOSED

MIGRATORY BIRD TREATY ACT CASES

There was a decrease of 133 cases from the total of the preceding fiscal year in the number of violations of the Migratory Bird Treaty Act reported by the Department for Federal prosecution, but an increase of 65 in the number of convictions, and an increase of 208 in the number of cases disposed of (table 5).

Of the cases reported, 87 were not recommended for prosecution because of lack of evidence, youthfulness of the accused, or other satisfactory reasons. Fines ranging from $1 to $500 and costs, and aggregating $10,500, were imposed in Federal courts. Four fines of $100 each and five of $25 each were suspended. Verdicts of guilty were returned by juries in five cases. In two cases the violators were denied hunting privileges for 2 years. Jail sentences were imposed as follows: 1 day in custody of marshal (2), 2 days (2), 30 days (11), 60 days (3), 90 days (9), 4 months (1), 6 months (6), 12 months (1), 18 months (1), or a total of 3,311 jail-days.

Two jail sentences of 90 days, eight of 6 months, and one of 12 months, totaling 1,980 days were suspended.

Defendants in 65 cases were placed on probation as follows: 4 for 2 months, 2 for 90 days, 11 for 6 months, 7 for 1 year, 19 for 18 months, 9 for 2 years, 8 for 3 years, and 5 for 5 years.

TABLE 5.—*Cases of violation of the Migratory Bird Treaty Act disposed of during the fiscal year and cases still pending June 30, 1936*

Disposed of	Number	Pending	Number
Convictions	423	From former year	540
Dismissals	46	New cases	482
Verdicts of not guilty	46		
Adjudged not guilty by court	4	Total	1,022
No bills found	14	Disposed of	632
Nol-prossed	34		
Prosecutions abandoned	65	Pending at end of year	390
Total	632		

Cases of note are as follows: For killing ducks and geese in close season in South Dakota 15 violators were each placed on probation for 18 months. In Missouri three violators were each fined $100 for possession of wild ducks in close season. In two other cases in the same State involving hunting of ducks in close season a 6-month jail sentence was suspended and defendants placed on probation for 3 years. In Colorado a defendant after being adjudged guilty was fined $100 for killing ducks in close season. For similar offenses two fines of $500 each and a 6 month jail sentence in one case were imposed in Wisconsin. In California fines for purchasing and selling ducks ranged from $50 to $300, with jail sentences of 3 to 18 months. For killing wild ducks on a rice field in California, one fine of $300 and two of $150 were imposed, the defendant in one case receiving, in addition to the fine, a jail sentence of 30 days. In North Carolina one violator was fined $100 and placed on probation for 2 years for hunting waterfowl with an unplugged gun and after 4 p. m. In Michigan $100 was assessed as a fine for killing ducks after 4 p. m., and in Kentucky a similar fine was imposed for killing ducks in close season. In Texas two violators were fined $50 and $100, respectively, for selling ducks. In five cases of hunting over bait in California and Ohio four were given fines of $25 and one $100. Cases involving hunting from a blind over 100 feet from shore line or vegetation in Michigan numbered four, in which fines of $100 were imposed. For the same offense in North Carolina a fine of $175 or 6 months in jail was imposed. Fines of $25 and $100 were meted out to two violators in Ohio hunting waterfowl over

baited areas with live decoys. For hunting woodcock in close season in Louisiana two violators were placed on probation for 5 years and, in the same State, for selling woodcock four offenders were given 30-day jail sentences, while another was placed on probation for 5 years. In Michigan one hunter paid a fine of $100 for shooting migratory game birds with an unplugged gun. Fines of $25 each were paid by two violators for illegally transporting live quail from Mississippi to Illinois. In Virginia fines of $25 each and 30 days in jail were imposed against two persons for trapping and possessing wild ducks in close season.

MIGRATORY BIRD CONSERVATION ACT CASES

The first case under the Migratory Bird Conservation Act, involving the unlawful taking of turtle eggs on the Cape Romain Migratory Bird Refuge in South Carolina, was terminated October 14, 1935, when the defendant, on a plea of guilty, was fined $10. Three other cases are still pending.

MIGRATORY BIRD HUNTING STAMP ACT CASES

One hundred and four cases involving infractions of the Migratory Bird Hunting Stamp Act were reported for prosecution. In the 39 cases closed the fines ranged from $1 to $100.

WILDLIFE REFUGE TRESPASS CASES

Six new cases under the law protecting wildlife and Government property on Federal reservations (sec. 84, Criminal Code) were reported. Of these and the previously pending cases, nine were closed, eight resulting in fines of from $5 to $100 and one being dismissed. Four are still pending.

LACEY ACT CASES

Since the Lacey Act was amended on June 15, 1935, there have been eight cases submitted for Federal prosecution. In two of these the grand jury failed to return true bills, while in two others the accused were adjudged not guilty by the court after trials lasting several hours. One defendant charged with unlawfully transporting furs was fined $25. Two others, arraigned for illegally transporting deer interstate for sale, were each sentenced to 13 months in jail, and another for a similar offense was given 4 months. A case pending from the previous year involving the transportation of a deer contrary to State law was closed by a fine of $10.

Information relating to infractions of State game laws was discovered by game agents operating under this statute as a result of inspections at fur-receiving centers in 20 States. Data relating to 2,626 apparently illegal shipments of skins of fur animals were furnished to game departments in 39 States, Alaska, and Canada. In 18 States 168 cases based on information originally furnished by the Bureau were closed by fines and costs of $3,424, and in 8 of these States jail sentences from 10 to 30 days were imposed in 15 cases. In 1,284 other investigations reported on by the States it was determined that shipments had been lawfully made, and in 117 others that prosecution would be inadvisable.

The game departments of 38 States were furnished evidence regarding 533 cases involving violations other than illegal interstate shipments of skins of fur-bearing animals. Prosecutions of these resulted in fines and costs in State courts amounting to $15,573. In 7 cases defendants were adjudged not guilty; in 519 cases convictions were obtained; 7 cases were dismissed; and 15 sentences ranging from 7 days to 175 days were imposed.

UPPER MISSISSIPPI RIVER REFUGE CASES

During the year 11 new cases of violation of the Upper Mississippi River Wildlife and Fish Refuge Act were reported for prosecution and 10 cases were pending in Federal court at the close of the year. Eleven cases were terminated, one by a fine of $25, one of $15, and two of $1 each. One sentence of 3 months in jail was suspended and the violator was placed on probation for 3 years. Six-month jail sentences were suspended in three cases and the defendants placed on probation for 1 year. Two other violators received suspended jail sentences of 2 months each. One case was nol-prossed.

Twenty-one cases based on information reported by refuge protectors involving State game-law offenses were successfully concluded in State courts, the fines and costs totaling more than $500. Jail sentences were imposed in four cases, 30 days in three, and 60 days in one.

COURT RULINGS OF NOTE

A bill on behalf of certain hunting clubs seeking to enjoin United States marshals, attorneys, and game-management agents, deputies, and employees from enforcing or making arrests for violations of the regulations relating to the open season and the killing of waterfowl by use of bait and other means, was filed in the southern district of Illinois. The bill of complaint was dismissed by the court, which in the course of its opinion stated:

> From authorities above quoted and from many others which might be quoted it seems plain to this court that plaintiffs have no property right in the migratory birds described in the regulations complained of; and having no property right in the birds they have only such permissive privileges as the governmental authorities may decree.

and added further:

> It is the conclusion of this court from a study of many cases that it is the general and perhaps the universal rule that public officers will be enjoined from the enforcement of State or Federal laws only when the party seeking such injunction has a definite property right which will, without such relief, be damaged or destroyed.

A suit to enjoin enforcement of the regulation shortening the season for shooting mourning doves was filed in the eastern district of Kentucky. The court stated:

> I am of the opinion that the congressional acts herein challenged and the regulations made thereunder should be declared valid and constitutional, that the injunction sought should be denied and the defendants' motion to dismiss this action should be sustained.

and added further:

> Concern for the welfare and protection of our migratory birds is not by any means limited to those whose chief interest in them rests in the sport of hunting and killing them. The object of providing for their protection and preservation reaches far beyond the motive of the huntsmen and the sport of hunting.

In the southern district of Georgia a demurrer was filed to an indictment charging that the defendant hunted mourning doves on and over an area that had been baited to attract the birds contrary to the regulations. In overruling the demurrer the court stated in part (citing *Panama Refining Co.* v. *Ryan* and *Schechter* v. *United States*):

> Congress in this case surely lays down "its policies and establishes its standards", namely, the policy that there shall be no hunting of migratory birds except as may be permitted by the Secretary of Agriculture. The standard is that the means of hunting shall be "compatible with the terms of the Convention." The "due regard" is not without its limitations and does not permit the unlimited exercise of discretion. The "due regard" must have reference to "the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds."
>
> It seems clear to me that this delegation is well within the prescribed rule referred to above.

and added further:

> The objection that this indictment violates that portion of the fifth amendment to the Constitution of the United States that "No person shall be * * * deprived of life, liberty, or property, without due process of law" seems to me unfounded. The prohibition of hunting is general. The lawful right to hunt is only where there has been a permission granted by the Secretary of Agriculture. Permission to hunt doves over a baited field is affirmatively prohibited. Thus we have the act prohibiting hunting altogether unless permission be had, and not only an absence of that permission but a positive prohibition by the Secretary of Agriculture that hunting in this way will not be allowed.

In Federal court for the western district of Missouri a bill seeking a temporary restraining order against enforcement of the Federal regulation not permitting the use of live duck decoys was filed by manufacturers of phonograph records reproducing natural calls of migratory birds. The application was denied.

WILDLIFE CONSERVATION IN ALASKA

Entering its twelfth year of wildlife conservation in Alaska, the Alaska Game Commission reports ample cause for satisfaction in the changed outlook of Alaskan residents. Gradually, and with much study, regulations have been molded to fit the conservation needs of the Territory, and slowly the results of their careful administration have operated to increase public support.

Knowledge of the important part played by game and fur animals in the economy of the Territory's population has become widespread, and with this knowledge has come a fear that unless this natural resource is safeguarded against indiscriminate taking, the sad story of the States will be repeated in America's last extensive stronghold of game. There is also a more general appreciation of the benefits accruing to the people through the expenditures of nonresident sportsmen who annually visit the Territory, attracted by the opportunity to take even a relatively small number of game trophies.

LAW ENFORCEMENT

Several changes were made in regulations for the 1936–37 hunting and trapping season under the Alaska Game Law. An open season on marten was provided throughout the Territory. Following a special open season on beaver in parts of western Alaska during the spring of 1936, the taking of these fur bearers was prohibited during the ensuing fiscal year. After a year's trial in the first judicial division (southeastern Alaska) the $1 resident hunting license provision was extended to the entire Territory.

By exercising stringent economy the commission was able to maintain eight full-time game wardens. Each of these officers, though handicapped by lack of funds, is charged with enforcement of game and fur laws in wilderness areas averaging 7,500 square miles each, as a result of which many places have not been visited by the wardens for several years. A minimum of 14 wardens has long been the aim of the commission, together with an increase of funds for operating its patrol vessels and maintaining proper records in its executive office at Juneau.

RESTOCKING PROJECTS

The results of restocking experiments, in addition to the transfer of musk oxen and buffalo, already noted (p. 7), may be briefly summarized as follows:

The 225 pheasants transplanted to Baranof Island during the summer of 1934 have raised several broods to maturity. On the Kodiak-Afognak Island group the small group of Olympic elk which was planted there 7 years ago is now said to number not less than 80 animals and is self-sustaining.

Other successful transplantings have been effected during the past few years with mountain goats, black-tailed deer, beavers, muskrats, martens, hares, squirrels, and marmots.

PREDATORY-ANIMAL CONTROL

In spite of a Territorial bounty of $20 each on wolves and coyotes, these predators have increased in an alarming manner during the past year, particularly among the reindeer of the Arctic coast, where their presence is decimating the herds and is having a demoralizing effect on native Eskimo reindeer owners.

IMPORTATION AND OTHER PERMITS ISSUED

ADDITIONAL FOREIGN SPECIES EXCLUDED

On February 20, 1936, the Treasury Department put into effect by Treasury Decision 48173, addressed to collectors of customs and others concerned, an order of December 26, 1935, issued by the Secretary of Agriculture under the Lacey Act of May 25, 1900, declaring injurious to agriculture and horticulture the skylark, common or house myna, crested or Chinese myna, European bullfinch, European yellowhammer, greenfinch, chaffinch, the black or house rat, roof rat, common or brown rat, common or house mouse, European rabbit, European hare, all species of mongooses of the family *Mungotidae*, and all species of fruit bats of the family *Pteropodidae*. As a consequence of the order the foregoing species of birds and mammals can no longer be imported into the United States for any purpose, being now classed with the starling and English sparrow, which are expressly mentioned in that act as excluded from the United States.

Because of these exclusions it has been necessary to exercise a much more extensive supervision over, and inspection of, foreign animals and birds offered for entry. A conference was had with the officers of the customs in New York City in June with a view to effective exclusion of the birds and mammals specified in the new order.

It is gratifying to repeat that no forbidden species of bird or mammal has established a foothold in the United States since 1900. The English sparrow and

starling had already become established in this country at the time the Lacey Act was passed, but their numbers have not been augmented by any further importations. Warnings issued during the year in connection with the confiscation of the fruit bats, which an importer had attempted to bring into the United States, have forestalled any further attempts during this year to import these or any other prohibited species.

Practically without exception, importation permits leave this Bureau on the day applications for permits are received. That the applicants appreciate this prompt response is attested by expressions that reach the Survey from time to time. If any delay in issuing permits occurs, it is due to failure of applicants to state one or more of the essential facts with reference to an importation that must be had before a permit can be issued. Such an omission is promptly called to the attention of the applicant.

SMUGGLING ATTEMPTS FRUSTRATED

On March 27 two seamen aboard a steamer from Italy, detected in an attempt to smuggle in 30 canaries at New York, were fined $60 in addition to the regular import duty. The master of the vessel was also fined $120 for permitting illegal landing of the birds and for failure to manifest them. A month later, when this steamer again docked at New York, another attempt was made to smuggle in 12 canaries, 2 cardinals, and 1 parakeet. The smuggler in this case was a longshoreman, who went aboard the vessel at the dock and conspired with the ship's cook to bring the birds ashore. This attempt also was frustrated when a customs guard became suspicious of the movements of the longshoreman on leaving the vessel. He was searched and the birds were found concealed in his clothing. An investigation disclosed that the cook on board was the instigator of the conspiracy, and he was fined $91.

SPECIES ENTERED UNDER PERMIT

BIRDS

Importation permits issued during the year numbered 1,462, and the inspections numbered 170. For the entry of 1,096 miscellaneous birds at Honolulu, Hawaii, 44 additional permits were issued at that port. A substantial increase in the number of foreign birds imported, especially canaries, is shown by comparison of the 230,140 entries this year with 197,100 last. Included in the total were 173,422 canaries, 2,214 parrots, 27,783 Mexican quail, 500 Hungarian partridges, 567 pheasants, and 25,654 miscellaneous birds. Eight hundred additional birds were also imported at San Juan, Puerto Rico.

Hungarian partridges continued to be imported from Canada but in somewhat smaller numbers than previously, and in November a shipment of 216 came from Czechoslovakia, the first in several years from that country, although previously this was the principal source of the North American supply. Several other species of partridges were imported from India and the Orient, including chukars, peura or hill partridges, snow partridges, Chinese partridges, and Bornean wood partridges.

Among the many species of pheasants entered were 19 Malay crestless firebacks (*Acomus erythrophthalmus*) from Sumatra, 2 Bulwer's pheasants (*Lobiophasis bulweri*) from Borneo, 1 Temminck's tragopan (*Tragopan temminckii*) from China, 6 Kaleege pheasants (*Gennaeus leucomelanos*), and 19 Impeyan pheasants (*Lophophorus impejanus*) from India; and 2 Blyth's tragopans (*T. blythii*), 2 Edward's Kaleege pheasants (*Hierophasis edwardsi*), and 2 bronze-tailed pheasants (*Chalcurus chalcurus*) in a shipment from France.

Although no new outbreaks of psittacosis have been reported recently, the quarantine regulations and restrictions of the Public Health Service on the importation of birds of the parrot family continue in force. There has been a noticeable increase, however, in the number of parrots imported, the many species including Amazons, African gray parrots, parakeets, macaws, cockatoos, lories, and conures. Among the more interesting imports were 2 racket-tailed parakeets (*Prioniturus platurus*), 9 Miller's parakeets (*Tanygnathus mülleri*), 5 yellow-backed lories (*Domicella garrulus*), and one green-naped lory (*Trichoglossus haematodus*) from Soerabaya, Java; and 7 Tahitian lories (*Coriphilus peruvianus*) and 2 ultramarine lories (*C. ultramarine*) from Papeete, Tahiti.

Other rare and interesting birds imported during the year included 2 magnificent birds of paradise (*Diphyllodes magnificus*) from New Guinea; 2 racket-tailed drongos (*Dissemurus paradiseus*) from the Malay Peninsula; 6 fairy bluebirds (*Grandala coelicolor*) from the Orient; 3 red-plumed pigeons (*Lophophaps ferruginea*) and 109 Siamese peace doves (*Spilopelia tigrina*) from Singapore, Straits Settlements; 2 Imperial fruit pigeons (*Muscadivores aenea sylvatica*) from Soerabaya, Java; 9 Gold Coast blue-headed doves (*Turtur afer*) from West Africa; 40 emerald spotted doves (*T. chalcospilos*) from Cape Town, South Africa; 1 twin-spotted finch (*Hypargos niveiguttatus*) from Portuguese East Africa; 5 boat-billed herons (*Cochlearius cochlearius*) and 2 bare-necked cotingas (*Gymnoderus foetidus*) from Brazil; 2 South American pitangas (*Pitangus sulphuratus*) and 17 giant orioles (*Gymnomystax mexicanus*) from Venezuela; 2 pileated sparrows (*Brachyspiza capensis*), 1 chestnut-capped buarremon (*Buarremon brunneinuchus*) and 1 rose-breasted grosbeak (*Hedymeles ludovicianus*) from Colombia; 3 olive pitylus (*Pitylus canadensis*) and 2 Cayenne leistes (*Leistes militaris*) from British Guiana; and 7 Ricord's emerald hummingbirds (*Riccordia ricordii*) from Cuba.

The number of bobwhite quail imported from Mexico was 27,783, exceeding last year's imports by 4,425. All were entered at Texas ports, 16,000 at Laredo and 11,783 at Eagle Pass. Health examinations were made at these ports and permits issued by inspectors of the Bureau of Animal Industry, cooperating with this Bureau, as in former years. The Mexican Government greatly curtailed the number allowed to be exported this year, and, despite a heavy demand, granted concessions for only 28,000, or less than half the number of last year. Imported quail were shipped to five States: Indiana, 13,203; Mississippi, 11,332; Texas, 3,055; New York, 100; and Tennessee, 50.

MAMMALS

The importation of black-bear cubs from Canada continued with only a slight decrease from the number imported last year. Permits were issued for 52 shipments, aggregating 102, whereas last year 128 were entered. These bears were principally from Manitoba, Ontario, and Quebec and were destined principally for points in New Jersey, Pennsylvania, Michigan, Oklahoma, and California.

Monkeys in considerable variety were imported, including representatives of such larger species as baboons, gorillas, chimpanzees, orangutans, gibbons, and wanderoos, from West Africa and the Orient. Those imported from tropical America included ring-tailed monkeys, woolly monkeys, marmosets, and capuchins. Unusually large numbers of rhesus monkeys were imported from India, the total of 12,992 being the highest ever recorded in any year and more than double the number imported last year. Three guenon monkeys (*Lasiopyga princeps*) were also imported from the Belgian Congo.

Among the more interesting mammals were 7 hyraxes (*Procavia* sp.) from East Africa; 3 galagos (1 *Galago zuluensis* and 2 *G. granti*) from South Africa; 5 solenodons (*Solenodon paradoxus*) from the Dominican Republic; 20 vampire bats (*Desmodus rotundus murinus*) from Costa Rica; 4 giant vampire bats (*Vampyrus spectrum*) from the British West Indies; 10 hutias (*Capromys pilorides*) from Cuba; 1 tree kangaroo (*Dendrolagus ursinus*) from the Malay Peninsula; and 12 pandas (*Ailurus fulgens*) from India.

RECENT FOREIGN LEGISLATION AFFECTING IMPORTATIONS

The Mexican Government, by a decree of April 3, 1936, made drastic changes and curtailments in the seasons for hunting various species of game in that country, closing the season indefinitely on some species and on others closing it indefinitely for sport with a short open season for commercial purposes, and vice versa. The open season for quail and partridge is now November 1 to the last day of February, instead of January 1 to April 30, as previously. Game taken contrary to the decree cannot legally be brought into this country.

Under a decree law of the Cuban Government, also dated April 3, 1936, no live birds or game animals may be exported from Cuba for a period of 20 years, except those destined for museums or foreign scientific organizations, and then only under a permit from the Government upon payment of certain fees. Flamingoes, cranes, wild ducks, and wild pigeons cannot be exported under any circumstances.

The Ecuadorean Government, by a decree of August 31, 1934, prohibits the catching, disturbing, or killing of certain species of birds and mammals on the

islands and in the waters of the Galapagos Archipelago, including the fur seal (*Arctocephalus galapagoensis*), the sea lion (*Otaria byronia*), the pelican (*Diomedea irrorata*), the Galapagos penguin (*Spheniscus mendiculus*), the wading cormorant (*Nannopterum harrisi*), the flamingo (*Phonicopterus ruber*), the Galapagos duck (*Paesilonitta galapagoensis*), the Galapagos pigeon (*Mesopelia galapagoensis*). As a consequence of this prohibition this Department does not issue permits to import such animals and birds unless application for the permit is accompanied by evidence of authority to export them from Ecuador, and the Treasury Department (T. D. 48173, supra) also requires consular certificates before permitting these birds or mammals, or parts or products thereof, to enter through the customs.

PERMITS UNDER MIGRATORY BIRD TREATY ACT

FOR SCIENTIFIC PURPOSES

Permits to take migratory birds for scientific purposes heretofore have been withheld in most cases until the applicant has exhibited a permit issued to him by each State in which he proposed to operate or until the Bureau had communicated with the State game department to ascertain whether it had issued or would issue the required State permit. This has entailed much clerical work and in some instances resulted in irritating delays without offsetting advantage. Reluctant, however, to alter the practice without consulting the various State game departments, the Bureau early in the calendar year submitted to each a plan whereby a Federal permit would be issued without previous communication with them, expressly conditioned upon the holder of the permit having in his possession a State permit prior to the exercise of any privilege given by Federal permit.

With no adverse responses from the State game departments and few countersuggestions, it was proposed as an effective economy that after July 1, 1936, the Bureau will issue these conditional permits to those applicants who establish qualifications therefor, ordinarily without previous communication with the State game department. But the applicant will be warned both by the conditional terms of the permit and by emphasis in the letter of transmittal that if he operates under the Federal permit without having in his possession a valid State permit he thereby subjects himself to the penalties of the Migratory Bird Treaty Act as well as forfeiture of the permit. These permits also will hereafter be issued without limitation of time, but subject to revocation at the discretion of the Secretary and to forfeiture for violation of the terms of the permit or of the law under which issued.

Federal permits will no longer confer the privilege of buying or selling migratory birds for scientific purposes, such privileges having been found to admit of abuse. If public or private institutions or any individual investigators require specimens for the success of their investigations, a special permit will be issued to allow the purchase of designated specimens from designated agencies, and if the agencies are found to be trustworthy, permits will be issued to them to make the sale.

For taking migratory birds for scientific purposes 809 permits were issued during the year, a substantial number having been issued to the Bureau's personnel throughout the country to enable them, if the opportunity arises, to obtain needed specimens for the Bureau's scientific investigations.

For possessing and transporting migratory birds for scientific purposes 64 permits were issued, and 156 special permits for the possession of one or a few specimens found dead and desired to be salvaged. Permits to take migratory birds for banding purposes numbered 177.

During the year 28 permits were issued to take specimens of birds and mammals in Alaska and to possess and transport them for scientific purposes.

FOR PROPAGATING GAME

Permits to propagate migratory waterfowl will be conditioned, as are the permits to collect migratory birds for scientific purposes, upon possession of a State permit. Furthermore, all migratory waterfowl raised under a propagating permit and killed and sold for food must have had removed from the web of one foot, before attaining the age of 4 weeks, a portion thereof in the form of a V large enough to make a permanent, well-defined mark sufficient to identify it as a bird raised in domestication under a permit. Heretofore only propagated waterfowl that were killed by shooting were required to be so marked.

Permits to take migratory waterfowl for propagation were issued to 21 applicants, each permit limiting the number and the time to be taken. There were outstanding at the close of the year 4,112 permits to possess, buy, and sell migratory waterfowl for propagation and to sell and transport dead bodies of propagated migratory waterfowl for food.

From reports submitted by permittees for the fiscal year it appears that 4,324 wild geese and 51,717 wild ducks were raised in captivity. Of the latter, 46,692 were mallards, 3,686 black ducks, and the remainder mainly wood ducks, pintails, teals, gadwalls, canvasbacks, baldpates, and redheads.

Migratory waterfowl propagated and sold during the year included 13,980 ducks and 406 geese for food, and 5,974 ducks and 1,858 geese for propagation. The reports show that 14,354 ducks and 674 geese were released to revert to the wild state.

PERMITS FOR SPECIAL USES OF REFUGES

For grazing, hay harvesting, and other special uses on wildlife refuges, including the big-game preserves, 161 special-use permits were issued. This number includes nonfee fishing permits but not permits issued by the superintendent of the Upper Mississippi River Refuge or by the administrative officer in Alaska in charge of the Aleutian Islands Refuge. The revenue derived from the special-use permits requiring the payment of a fee aggregated $19,163.94.

COOPERATIVE CONTROL OF INJURIOUS SPECIES

Expenditures during the year in cooperative predator and rodent control operations included $599,482 from regular departmental appropriations, supplemented by $305,381 spent by cooperating States and $739,089 by cooperating counties, livestock associations, and others. In addition about $1,000,000 in emergency funds was expended on work under Biological Survey supervision. The year's catch of predators by the Bureau and its cooperating agencies, aggregating 73,127, exceeded last year's record by 6,465, and consisted of 64,566 coyotes, 1,115 wolves, 6,980 bobcats and lynxes, 6 ocelots, 173 bears, and 287 mountain lions. Rodent control involved the treatment of 32,547,769 acres infested with prairie dogs, ground squirrels, pocket gophers, jack rabbits, porcupines, field mice, cotton rats, kangaroo rats, and woodchucks. In addition 83,566 premises were treated in cooperative campaigns for the control of the common brown rat. Control activities were extended during the year to North Dakota, Missouri, and Hawaii.

A general conference of all permanent civil-service employees of the Bureau engaged on predator and rodent control was held in Denver, Colo., April 20 to 24, to correlate the work further and to review policies and make recommendations for the further guidance of control projects.

During the year a manuscript was prepared for publication as a leaflet on coyote-den hunting. Leaflet No. 109, entitled "Eliminating Bats From Buildings", was published in September, and Circular No. 381, entitled "Rodents and Moles as Pests in Bulb Plantings" in February. Leaflets on control issued in mimeographed form included Bounties Paid By States (BS–24, above mentioned); Rodent Control Aided by Emergency Conservation Work (BS–54); and Directions for Organizing and Conducting Rabbit Drives (BS–59).

PREDATORY ANIMALS

In North Dakota and Missouri predatory animals had become increasingly abundant, and urgent requests were received for assistance in control. In McKenzie County, N. Dak., the losses from their depredations were as high as 65 percent of the lamb crop, and severe losses also were sustained among flocks of turkeys and chickens and among calves.

The continuing increase of predators, especially coyotes, over wide areas in the western part of the United States is seriously affecting profits in the livestock industry as well as the desired increase among various species of game animals and ground-nesting birds. In Webb County, Tex., during the last 6 years and 2 months, 23,235 predatory animals, consisting of coyotes, bobcats, mountain lions, and ocelots, were taken by Federal and cooperative hunters. This means that over the whole period one predator has been taken on each 88.67 acres of Webb County, or an annual average of one predator per 546.8 of the 2,060,160 acres of the county. A decrease in the catch of predators in the county has been noted, however, year by year, and at the same time the

number of game animals, especially deer, has increased materially. While this is true of a great many areas throughout the Western States where it has been possible to reduce somewhat the number of predators, on the greater percentage of the ranges coyotes have become more numerous, and their depredations among livestock, game animals, and ground-nesting birds have increased accordingly.

In western Colorado 6 years ago a take of 100 predators was considered a good year's work for an individual man. During the past year one man working in this area took a total of 509 predators, consisting of 388 coyotes, 119 bobcats, and 2 bears. Other hunters in the State individually captured 447, 445, 413, 276, and 272 during the year. These large individual takes show that predators, especially coyotes, are more abundant than they were 6 years ago on the same areas. In Wyoming also an individual hunter captured 414 predators in 265 days.

The interest in and the need for predatory-animal control was further demonstrated in Texas, where during the fiscal year 11 wolf clubs that were organized for raising funds for control work, 49 county commissioners' courts, 95 individuals, and 3 local game commissions provided funds in the amount of $46,990.83 for the prosecution of predatory animal control in their respective communities. When predatory animal control was inaugurated in Texas in 1915 it was not unusual for men engaged in sheep and goat raising in Tom Green, Crockett, Schleicher, Sutton, and neighboring counties to sustain annual losses from coyotes of 10 percent or more. Because of control of these predators, losses in this section during the past year were not more than a fraction of 1 percent. The control work in 1915 was confined to the sheep and goat country, but since that time it has been possible to operate in bordering counties to prevent reinfestation in sheep and goat-raising sections. Though sheep in Texas have declined since 1930 approximately 18 percent in nine counties that had 200,000 or more each, the sheep population in adjoining counties having 1,000 to 60,000 each, has increased 31 percent, largely because of predatory animal control work.

A typical illustration is Parker County, Tex., where within the last 5 years the sheep population has increased 300 percent, a result made possible largely by the control work inaugurated in 1927. During the first year of control operations, 100 red wolves were taken, and during the past year only 5.

The need for predator control is also demonstrated in Wyoming, where boards of county commissioners of 16 of the 23 counties, 22 local livestock associations, and 8 individuals cooperated financially to the amount of $28,490.71 for the purpose.

WOLVES AND COYOTES IN ALASKA

Predator control will be extended early in the coming year to Alaska, where wolves are now taking an excessive toll from reindeer herds. Native Eskimos and Indians in northern Alaska depend almost entirely upon reindeer for food, clothing, and transportation. These animals are raised under somewhat the same supervision as are cattle on the western ranges. Caribou distributed throughout interior Alaska constitute one of the chief human foods in the entire area, and Alaska law permits the killing of these animals in emergencies for food purposes at any time of the year. In the islands of southeastern Alaska deer are used extensively for food. The protection of these herds from severe depredations by wolves and coyotes is of great economic importance. Reports of hundreds of reindeer killed in one night are not uncommon, and aviators traveling in the Kotzebue Sound area report seeing 8 to 20 wolves along their route of travel. One report from Alaska indicates that more than 8,000 reindeer were killed during the winter of 1935–36, and that equally serious losses have been caused by the scattering of herds. Similar reports indicate depredations on mountain sheep, mountain goats, caribou, moose, and deer.

PREDATORS IN EASTERN STATES

Several years ago, when coyotes were first reported in Alabama, suppressive measures were undertaken by local agencies to prevent their establishment and spread in the South. During the past year it has developed that predators have reinfested eastern Alabama, not having been entirely eliminated by the previous effort. Early in May the State game department received complaints of a heavy infestation on a plantation in northern Russell County and adjoining Barbour County. Investigation showed that the animals have spread northeastward from this point into a swampy area northeast of the town of Uchee.

In this district, which comprises the main source of known infestation, one owner lost about 60 calves last year, and wild turkeys and rabbits have been seriously depleted. It is reported that predators have been in Russell County since about 1928 and that they have almost destroyed the wild turkeys, quail, and rabbits and have driven out the foxes. Another report states that they have destroyed the wild turkeys in Barbour County. During the coming fiscal year control work will be inaugurated in that part of Alabama and specimens will be collected for specific identification.

In January, following an investigation of reported presence of coyotes in Virginia, through the cooperation of a State game warden and residents of Grayson County, a litter of five puppies was taken from a den. The mother, later captured, was a coyote-dog cross, the puppies possibly being one-quarter coyote. In the immediate vicinity losses had occurred among lambs, turkeys, and chickens, so severe in sheep ranges as to necessitate the corraling of all sheep and lambs each night.

RODENTS

RATS IN HAWAII

A Hawaiian tax fund order approved by the President on October 14, 1935, authorized the expenditure of $110,000 for a rat-abatement campaign in the Hawaiian Islands. The Biological Survey cooperated by conducting research studies for control and stationed an expert in Hawaii to correlate control activities against the various species of rats inhabiting the islands—the Alexandrian rat (*Rattus rattus alexandrianus*), the black rat (*R. r. rattus*), the Hawaiian rat (*R. hawaiiensis*), and the common brown or Norway rat (*R. norvegicus*). The Alexandrian and black rats nest in trees or in rock piles and walls or under the dense cover of grass and brush and seldom burrow, whereas the Norway and Hawaiian species live in burrows in the fields and are rarely found about buildings. In many pineapple fields having a rat infestation of 15 to 25 to the acre, as much as 60 percent of the fruit crop has been destroyed. Severe damage has been inflicted also in rat-infested sugarcane fields.

This project was established in cooperation with the Territorial Board of Health, the University of Hawaii, the experiment station of the Hawaiian Sugar Planters Association, and the Board of Commissioners of Agriculture and Forestry of the Territory. Investigations in Hawaii have revealed exceptionally heavy infestations of rats in many areas, in some cases as high as 80 to the acre. Danger is not confined to the destruction of crops, but, what is of primary consideration to the people of the Territory, it includes also the risk of dissemination of bubonic plague.

RODENTS AND SOIL CONSERVATION

Rodent control became necessary on many extensive areas where range improvement for soil protection was involved, while in agricultural areas the higher prices received for farm products stimulated farmers to prevent rodent destruction of their crops. Livestock reduction on many areas in the Western States will be largely futile as a range-restoration measure unless rodent pressure on the same areas also can be reduced. Both are necessary to the revegetation of many areas, and this is basic to soil conservation.

In Baca County, Colo., on a project of the Soil Conservation Service where ground slopes had been terraced for the prevention of erosion, kangaroo rats had burrowed through the contour and diversion dikes on an 80-acre field. Later after a heavy rainfall, the water followed the burrows and almost completely destroyed soil-conserving structures, making it necessary to recontour and redike the entire field by hand. On other areas pocket gophers caused similar destruction. The control of rodents on such areas is imperative to success in the control of water run-off.

EMERGENCY CONTROL PROGRAMS

PLAINS SHELTERBELT

In cooperation with the Forest Service on the Plains Shelterbelt, protection from rodent damage was given to 1,278 miles of shelterbelt plantings in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. During the

prosecution of this work approximately 1,397,000 jack rabbits were destroyed, mostly by means of hunting. Many of these were distributed for food purposes. In one instance where the planting of a strip of shelterbelt was not reported to the control crew until about 10 days later, a large majority of the trees had been destroyed by jack rabbits; on other areas where rodent control had been carried on simultaneously with the planting operations, little such damage was suffered.

EMERGENCY CONSERVATION WORK

The E. C. W. program has been of inestimable value in the control of prairie dogs, ground squirrels, pocket gophers, kangaroo rats, and other native rodents. Western farmers have been forced to carry on campaigns against these rodents ever since the settlers first staked out claims on the prairies. The control of rodents is as vital to western agriculture as is the proper spraying of orchard trees in the East to prevent damage by insects. Rodents cover the western ranges by countless thousands, and control is necessary if crops are to be grown.

For safeguarding poisoning operations and for the protection of beneficial and harmless species, the Biological Survey supervises all rodent-control work for its various cooperating agencies. When poisoning campaigns are properly handled and carefully supervised, there is little danger of accidental poisoning of other animals. The records indicate that there have been practically no cases of destruction of other forms of life through the E. C. W. rodent-control program. Naturally, the supervisors not only must understand rodent control but also must be acquainted with the habits and status of wildlife in general. They have imparted knowledge to the crews that will be of permanent benefit to them and to the Nation.

On some of the Indian reservations of the Southwest, the situation as regards rodent infestation has been pitiful. The Indians on the Navajo Reservation, in particular, have carried on a losing fight against drought and rodents, often being forced to replant their corn three and four times a season, since kangaroo rats and other native rodents would dig up the kernels as soon as planted. Prior to the spring of 1935, there had been 3 years of drought, and this, coupled with rodent damage, had reduced corn production to the point where the Indians had barely enough for spring seeding. All were clamoring for aid, and in order to save their last crop of corn it was necessary to detail a foreman with four or five E. C. W. Indians to go from farm to farm and conduct rodent-control operations.

In its reforestation program throughout much of the cut-over area in the Lake States and the Pacific Northwest, one of the chief problems encountered by the Forest Service has been the control of rodents, particularly the snowshoe hare. In the Olympic National Forest, in Washington, this rodent has destroyed as much as 40 percent and damaged 70 percent of the Douglas fir seedlings. In Michigan and Wisconsin, it was necessary to carry on extensive rodent-control operations to permit the seedlings to survive. Much of this work would have been impossible but for the E. C. W. assistance.

To control prairie dogs in Oklahoma, one area of 47,000 acres in Pawnee, Noble, and Kay Counties was treated. The Indian lands here are interspersed with private lands, and the landowners were unable to make any progress in a general clean-up. This was because there were insufficient Federal funds to treat the Indian lands until the E. C. W. project made it possible to carry on a systematic campaign over the entire area. A good piece of work was accomplished, and the grass was so much better over these old prairie dog towns in the spring of 1935 that the Indian Service officials at Pawnee received an increase of 25 cents an acre on their grazing lands—or 50 percent more than in 1934—though the improvement was in part attributable to water development.

Rodent control was continued as a project in E. C. W. in cooperation with the Forest Service and the Soil Conservation Service of the Department of Agriculture; the Office of Indian Affairs, the Bureau of Reclamation, and the Division of Grazing of the Department of the Interior; and on big-game reservations of this Bureau. Under the various emergency projects it has been possible to reduce the number of destructive rodents over wide areas to the great benefit of range grasses and cultivated crops. These projects have also been responsible for protecting many soil-conservation structures from washouts during heavy rains. Although not all such damage has been prevented, it has been measurably reduced by rodent control.

OTHER EMERGENCY PROJECTS

Rodent-control programs were conducted in cooperation with State administrators of the Federal Emergency Relief Administration, the Works Progress Administration, and the Resettlement Administration in Arizona, Idaho, Louisiana, New Mexico, Montana, North Dakota, Oregon, Texas, Utah, and Washington. State W. P. A. projects for the control of predatory animals also were supervised by members of this Bureau.

In Utah, where predatory animals have increased materially during the last several years, because of a reduction in cooperative funds for the employment of hunters and the lowered value of predatory-animal furs, this W. P. A. project has made it possible to hold in check the depredations on livestock and game over many areas, although control of the predators has been accomplished on only part of the entire State.

RODENTS AND BUBONIC PLAGUE

An extension of bubonic plague among native rodents has been found by representatives of the Public Health Service in Montana and Idaho during the year, whereas formerly it was known to exist only in certain counties of California and Oregon. The spread of this dread disease is of no little concern to the population living in and adjacent to the localities where it has been discovered. It is also a matter of concern to the entire population of the States in which it exists as well as to the Nation. Rodent control has been undertaken on these areas, not only to eliminate the disease there but to prevent its further spread.

BAIT-MIXING STATION

The Bureau's bait-mixing station at Pocatello, Idaho, has been a prime factor in making it possible to conduct effective rodent-control programs in cooperation with the several States and with other departments of the Federal Government. The usefulness of this station has advanced during the year, and it has been used as a central depot for supplies and materials other than baits used in rodent-control campaigns. Recognizing the Bureau's need for a central supply depot, the Congress (by Pub. Res. No. 128, approved by the President on June 24, 1936) authorized the establishment of a game-management supply depot and laboratory at Pocatello, Idaho.

Since the cooperative bait-mixing station was established at Pocatello, scientifically prepared baits have been distributed to cooperators in every State in the Union except Arkansas, Tennessee, and Georgia. This year's output totaled 1,993,614 pounds. The mechanical operations of this station have included the manufacture of 2,000 adjustable pocket-gopher probes, the construction of automobile trailers, repairs to traps and field equipment, and distribution of certain other items of field equipment.

CONTROL METHODS RESEARCH

The Control Methods Research Laboratory maintained at Denver, Colo., for developing improved methods for the control of injurious mammal pests has made headway on several lines. Improved methods for the control of various species of rats in the Hawaiian Islands have been found and recommended for use in that Territory. Through scientific tests it was learned that baits placed in sausage casings are acceptable to rats in the pineapple fields, that they keep for a longer period when exposed, and that they are not attacked by insects.

New methods and modifications of older methods have been devised for the control of rodent pests, especially jack rabbits, on the shelterbelt project in the Great Plains region.

A standard red-squill preparation has been prepared for use in comparing samples of red squill when making purchases of this commodity. This reference sample is of known toxicity when used in rat control. Bio-assays will be made for specific comparison with the standard, thereby making it possible to purchase materials of ample strength for use in control campaigns.

Bio-assays also are being conducted to learn the reasons for variations in the action of strychnine in the control of injurious mammals. It has been found that different lots of this product, all having the same chemical purity, have varied greatly in their action.

Experiments and large-scale tests have correlated practices for the control of the Columbian ground squirrel in Oregon, Washington, and Idaho during the fiscal year, and a standard bait material for all of this territory has been adopted.

Studies for further developing methods of control of crawfish were continued with success in Mississippi, with special reference to procedure on a large-scale field basis. The area known as the black prairie belt, which extends southward from the Tennessee State line in northeastern Mississippi and then eastward nearly across Alabama, provides the natural habitat for crawfish (*Cambarus hageneanus* and possibly other closely related forms). The density of the crawfish infestation on this area while variable, ranges as high as 15,000 individuals per acre, or 1 to every 3 square feet, with maximum infestations not uncommon. In such cases farm crops, especially young cotton and corn, may be almost completely destroyed during warm rainy nights in spring, and several successive plantings may be necessitated. Such heavy losses have had a marked influence on the value of some of the most fertile land in Mississippi. The development in cooperation with State officials of practical methods of controlling crawfish will mean much to the future of this black prairie belt.

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